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(71) Applicant *(for all designated States except US)*: **NISSAN MOTOR CO., LTD.** [JP/JP]; 2, Takara-cho, Kanagawa-ku, Yokohama-shi, Kanagawa 221-0023 (JP).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **KATO, Kazuhito** [JP/JP]; 3-1-B-606, Kawabe-cho, Hodogaya-ku, Yokohama-shi, Kanagawa 240-0001 (JP). **KITAZAKI, Satoshi** [JP/JP]; 2-15-12, Kajigaya, Sakae-ku, Yokohama-shi, Kanagawa 247-0009 (JP). **NAKAJI, Yoshiharu** [JP/JP]; 2-41-74, Mutsukawa, Minami-ku, Yokohama-shi, Kanagawa 232-0066 (JP). **HIJIKATA, Shunsuke** [JP/JP]; 3-186-1-507, Negishi-cho, Naka-ku, Yokohama-shi, Kanagawa 231-0836 (JP). **HIRAO, Akinari** [JP/JP]; 52-17-C-102, Kawakami-cho, Totsuka-ku, Yokohama-shi, Kanagawa 244-0805 (JP).

(74) Agent: **SHIGA, Fujiya**; c/o Shiga Patent Office, Ekisaikai Bldg., 1-29, Akashi-cho, Chuo-ku, Tokyo 104-0044 (JP).

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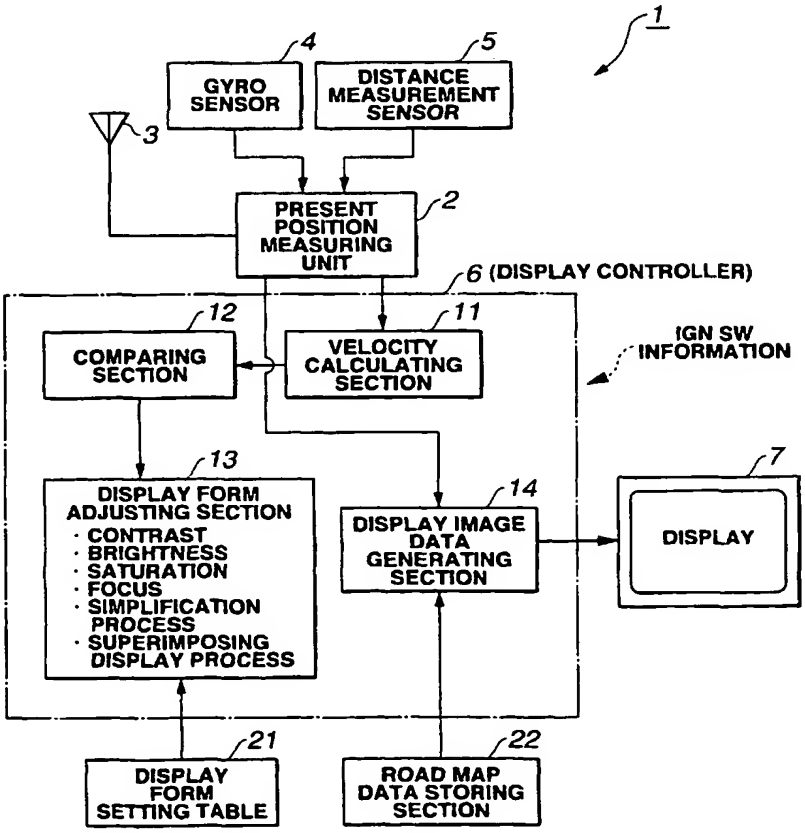
(54) Title: DISPLAY APPARATUS AND METHOD FOR AUTOMOTIVE VEHICLE



(57) Abstract: In display apparatus and method for an automotive vehicle in which an image display is mounted, a road map data image is stored in a storage medium, a mark representing the present position of the vehicle is superimposed on the road map data image, the road map data image is rotated on an image screen of the image display in accordance with a traveling direction of the vehicle while displaying the road map data image on an image screen of the image display, and a display form of the displayed road map data image is varied between a region of the road map data image which is near to a displayed position at which the vehicle is present and another region thereof which is remote from the displayed position thereof while rotating the road map data image on the image screen of the image display section.

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DESCRIPTION

DISPLAY APPARATUS AND METHOD FOR AUTOMOTIVE VEHICLE

Technical Field

The present invention relates to display apparatus and method for an automotive vehicle such as, so-called, car navigation system and method. The present invention, more particularly, relates to a technique for improving a visibility of an image displayed on an image screen of a display.

Background Art

A Japanese Patent Application First Publication No. Heisei 10-148534 published on June 2, 1998 exemplifies a previously proposed vehicular display apparatus. In the previously proposed vehicular display apparatus disclosed in the above-identified Japanese Patent Application First Publication, in a case where a vehicular steering wheel is steered toward a center of the vehicle in order to turn the vehicle, the image screen of the display is switched to a state in which a visibility of the whole image screen of the display is lowered so that a vehicular driver does not feel troublesome.

Disclosure of the Invention:

However, since, in the previously proposed vehicular display apparatus disclosed in the above-identified Japanese Patent Application First Publication, the visibility of the whole display image screen is modified, there is a possibility that the vehicular driver still feels troublesome.

It is, therefore, an object of the present invention to provide display apparatus and method for an automotive vehicle which meet a vehicular driving sense of the vehicular

driver while improving a visibility of the displayed image.

According to one aspect of the present invention, there is provided a display apparatus for an automotive vehicle, comprising: an image display section; a present position measuring section that measures a present position of the vehicle; a road map storing section that stores a road map data image; a superimpose processing section that superimposes a mark representing the present position of the vehicle on the road map data image to display the road map data image on which the mark is superimposed through the image display section; and display control section that rotates the road map data image displayed on an image screen of the image display section in accordance with a traveling direction of the vehicle and varies a display form of the displayed road map data image between a region of the road map data image which is near to a displayed position at which the vehicle is present and another region of the road map data image which is remote from the displayed position thereof when rotating the road map data image on the image screen displayed on the image display section.

This disclosure of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

Brief Description of the Drawings:

Fig. 1 is a block diagram representing a structure of a vehicular display apparatus according to the present invention related to each of first, second, third, fourth, fifth, and sixth preferred embodiments.

Fig. 2 is a block diagram representing a more detailed structure of vehicular display apparatus related to the first, third, and fourth preferred embodiments.

Fig. 3 is a processing flowchart representing a procedure of the vehicular display apparatus in the first

preferred embodiment.

Figs. 4A and 4B are characteristic curves on an image contrast preset in a display form setting table, respectively.

Fig. 5 is a photograph representing a display example of a displayed image on a display when the vehicle has traveled in a straight run.

Fig. 6 is a photograph representing a display example of a displayed image on display when a contrast of road map data image is changed during a rotation of road map.

Fig. 7 is a photograph of a display example of a road map data image when a brightness of the road map data image is varied during the rotation of road map data image.

Fig. 8A is a photograph of a display example of the road map data image when a focus of the road map data image is varied during the rotation of road map data image.

Fig. 8B is a photograph of a display example of the road map data image when a contrast of a region of the road map data image which surrounds an arrowed mark representing a present position of the vehicle is raised and that of another region of the road map data which is remote from the displayed arrowed mark is lowered.

Fig. 8C is a photograph representing a display example of the displayed image when a saturation of a region of the road map data image which surrounds the arrowed mark is lowered as compared with another region thereof which is remote from the arrowed mark.

Fig. 9 is a photograph representing an example of the road map data image in a form of a bird's eye view displayed on the display to which the present invention is applicable.

Fig. 10 is a photograph representing an example of the displayed road map data image in the form of the bird's eye view to which a contrast process described in the first

embodiment shown in Figs.1 and 2 is added.

Fig. 11 is a detailed block diagram of the vehicular display apparatus in the second preferred embodiment according to the present invention.

Fig. 12 is a characteristic graph representing an example of varying the display form according to a circumferential velocity V1 and a luminance of an area surrounding the vehicle used in the second embodiment shown in Fig. 11.

Fig. 13 is an operational flowchart representing a procedure of vehicular display apparatus in the third preferred embodiment according to the present invention.

Fig. 14 is a photograph of a display example of display representing a road map data image processed in a simplification process carried out in the third embodiment shown in Figs. 1 and 13.

Fig. 15 is an operational flowchart representing a procedure of vehicular display apparatus in the fourth preferred embodiment according to the present invention.

Fig. 16 is a photograph representing a display example of the displayed image of display when a ratio of a road map data image before a rotation of the road map data image to that after the rotation thereof is 10 : 0.

Fig. 17 is a photograph representing a display example of the displayed image of display when the ratio of the road map data image before the rotation of the road map data image to that after the rotation thereof is 7 : 3.

Fig. 18 is a photograph representing a display example of the displayed image of display when the ratio of road map data image before the rotation of the road map data image to that after the rotation thereof is 5 : 5.

Fig. 19 a photograph representing a display example of the displayed image of display when the ratio of road

map data image before the rotation of the road map data image to that after the rotation thereof is 3 : 7.

Fig. 20 is a photograph representing a display example of the displayed image of display when the ratio of road map data image before the rotation of the road map data image to that after the rotation thereof is 0 : 10.

Fig. 21 is an operational flowchart representing a procedure carried out in the vehicular display apparatus in the fifth preferred embodiment according to the present invention.

Fig. 22 is a block diagram of the structure of the vehicular display apparatus in the sixth preferred embodiment according to the present invention.

Figs. 23, 24, and 25 are integrally a procedure flowchart executed in the vehicular display apparatus of the sixth preferred embodiment shown in Figs. 1 and 22.

Fig. 26A is a timing chart representing start and end of a turning of the vehicle.

Figs. 26B, 26C, and 26D are timing charts representing start and end of the rotation of each display form varied road map data image.

Best Mode for Carrying Out the Invention:

Reference will hereinafter be made to the drawings in order to facilitate a better understanding of the present invention

Fig. 1 shows a whole configuration of a display apparatus for an automotive vehicle (hereinafter, also referred to as a vehicular display apparatus) related to each preferred embodiment according to the present invention. As shown in Fig. 1, vehicular display apparatus 1 includes: a present position measuring unit 2 which measures a present position of the vehicle (hereinafter, also referred to as a host vehicle); a GPS (Global Positioning System) antenna

2 which receives GPS signals radiated from a plurality of position measuring satellites; a gyro sensor 4 which measures a traveling direction of the host vehicle; a distance measurement sensor 5 which measures a running distance of the vehicle; a display (corresponding to image display means) 7; and a display controller 6 which controls an image display onto display 7.

Present position measuring unit 2 measures an absolute position of the host vehicle on the basis of a position measurement information received from GPS antenna 3. In addition, in a case where the GPS signals cannot be received, the present position of the vehicle is measured using a self-contained navigation (SCN) method based on the position measurement data obtained from gyro sensor 4 and distance sensor 5. It is noted that display 7 may be constituted by a liquid crystal display, present position measuring unit 2 and display controller 7 may be constituted by a microcomputer and its peripheral circuit.

Fig. 2 shows a functional block diagram representing a structure of the vehicular display apparatus 1 related to each of first, second, third, fourth, and fifth preferred embodiments according to the present invention. As shown in Fig. 2, display controller (corresponding to display control means) 6 includes a velocity calculating section 11; an (arithmetically) comparing section 12; a display form adjusting section 13; and a display image data generating section 14. In addition, display controller 6 includes a display form setting table which stores setting data needed when the display form adjusting section 13 adjusts the display form; and a road map data storing section 22 which stores a road map data image placed in a proximity to a running position of the host vehicle.

Velocity calculating section 11 detects a

circumferential velocity V1 at various points of places (given spots) on the road map data image displayed on display 7 along with a turn of the vehicle when the vehicular driver steers a vehicular steering wheel to turn the vehicle so that a traveling direction of the vehicle measured by present position measuring section 2 is changed. In addition, velocity calculating section 11 has a function to calculate a turning angle $\theta 1$ of the vehicle within a predetermined period of time when the traveling direction of the vehicle is changed, as will be described later in each of the third and fourth preferred embodiments.

In comparing section 12, a reference value Vref of the circumferential velocity is preset. Comparing section 12 compares the circumferential velocity V1 derived by velocity calculating section 11 with reference value Vref to determine whether the circumferential velocity V1 is larger than reference value Vref thereof. A signal indicating a result of the determination described above is supplied to display form adjusting section 13. In addition, another reference value θ ref of a turning angle of the vehicle with another predetermined period of time is preset in comparing section 12 as will be described later in each of the third and fourth preferred embodiments according to the present invention. Then, comparing section 12 compares the turning angle θ 1 derived by velocity calculating section 11 with reference value θ ref.

Display form adjusting section 13 carries out a proper modification (variation) of a display form of the road map data image displayed on display 7 when comparing section 12 determines that the circumferential velocity V1 of the image on display 7 is larger than a reference value Vref of circumferential velocity described above. The display form includes an image contrast, an image brightness, an

image saturation, and a simplification (simplifying process) of the displayed image. Display form adjusting section 13 adjusts at least one of display forms of these items on the basis of data stored in display form setting table 21 in such a procedure as will be described later.

Furthermore, display form adjusting section 13 has a function to implement a display process such as to superimpose a road map data image after the traveling direction of the vehicle is changed on that before the traveling direction of the vehicle is changed.

Display image data generating section 14 carries out a process of generating an image to be displayed on display 7 on the basis of road map data read from road map storing section 22, data on the present position of the vehicle and the traveling direction of the vehicle supplied from present position measuring unit 2, and data on various kinds of display forms supplied from display form adjusting section 13. It is noted that road map data storing section 22 may be constituted by an external storage medium and driver therefor.

Next, an operation of the first preferred embodiment of vehicular display apparatus 1 will be described with reference to a flowchart shown in Fig. 3.

At a step ST1, present position measuring section 2 measures the present position of the host vehicle on the basis of data obtained by GPS antenna 3 or by both of distance sensor 5 and gyro sensor 4. At the next step ST2, display image data generating section 14 reads road map data of a surrounding regional area with a point of place at which the vehicle is running as a center from road map data storing section 22. At the next step ST3, display image data generating section 14 superimposes a mark representing the position of the host vehicle on the road map data image.

At the next step ST4, display image data generating section 14 generates the image data to be displayed on display 7.

Next, if the vehicular driver steers a steering wheel of the vehicle to change the traveling direction of the vehicle (Yes at a step ST5), display image data generating section 14 rotates the road map data image with the position of the vehicle to be displayed as a center so as to adjust the traveling direction of the vehicle on display 7 to usually indicate the same direction as the actual traveling direction thereof. At the same time, velocity calculating section 11 calculates rotation velocity at various point of places (various given points) on the road map data image along with the steering operation, namely, circumferential velocities V1. It is noted that circumferential velocities V1 can easily be derived on the basis of a rotation velocity of the road map image data and respective distances of the respective points of places to the center of the image (viz., the position of the vehicle).

At a step ST6, comparing section 12 compares the preset reference value Vref of circumferential velocity (Vref is, for example, 50 mm/s (millimeter/second)) with each of circumferential velocities V1 calculated by velocity calculating section 11 to determine whether a position (a point of place) on the road map data image at which corresponding magnitude of circumferential velocity V1 becomes larger than reference value Vref is present on the image screen of display 7. If Yes at step ST6, namely, the above-described position on the road map data image is determined to be present, display form adjusting section 13 then carries out such a process as to adjust the image contrast along with the rotation of road map data image on the image screen of display 7 at the next step ST7. It is noted that although an adjustment on the contrast, as

one example, will herein be explained, the adjustment of brightness, saturation, focus, or a combination of these elements is possible.

The adjustment process of the contrast is set in accordance with a characteristic graph stored in display form setting table 21. Fig. 4A shows the characteristic graph representing a relationship between circumferential velocity V1 and contrast. As shown in Fig. 4A, at the position at which the corresponding magnitude of circumferential velocity V1 which is equal to or lower than 50 mm/s, a high contrast (the same contrast as that in an ordinary display) is maintained. Such a processing as reducing the contrast in the form of a first-order function with respect to an increase in circumferential velocity V1 when circumferential velocity V1 falls in a range between 50 mm/s and 150 mm/s is added. Furthermore, if circumferential velocity V1 is in excess of 150 mm/s, such a process as to reduce further the contrast is not carried out.

Then, the image to which the adjustment process of the contrast is added is displayed on the image screen of display 7 (at a step ST8 in Fig. 3). Thereafter, the above-described series of processes of steps ST1 through ST8 are repeated until an ignition switch of the host vehicle is turned off (Yes at a step ST9).

Fig. 5 shows a display example of display 7 when the vehicle (the present position (including the traveling direction) is represented by an arrowed mark in red) is running ordinarily (or normally).

Fig. 6 shows a display example of the image screen of display 7 when the contrast of the road map data image displayed through display 7 is varied when the traveling direction of the host vehicle is changed.

As appreciated from Figs. 5 and 6, the road map data image displayed on the image screen of display 7 is adjusted in such a manner that, as the road map data image becomes apart from the displayed position of the vehicle (represented by the arrowed mark), the contrast thereon becomes generally lowered. Hence, when the traveling direction of the vehicle is changed at, for example, a traffic intersection, a vehicular occupant (including vehicular driver) can avoid a troublesomeness caused by the rotation of the road map data image on the image screen of display 7 so that the visibility of road map data image can be improved.

In the first embodiment, the example of setting the relationship between circumferential velocity V1 and contrast of road map data image using the characteristic graph as shown in Fig. 4A has been explained. However, the present invention is not limited to this. That is to say, as shown in a characteristic graph of Fig. 4B, it is also possible to reduce the contrast in the form of the first-order function as a region of the road map data image becomes remote from the rotation center of the road map data image. In this case, such a comparison process as comparing circumferential velocity V1 with reference value Vref of circumferential velocity in the comparing section 12 can be omitted.

In addition, in the first embodiment, circumferential velocity V1 on each of various points of places is derived and the display form such as the contrast is changed on the basis of a magnitude of circumferential velocity V1. However, the present invention is not limited to this. It is possible to vary the display form on the basis of an angular velocity AV of each of the various points of places, each distance D of the various points of places

from the rotation center, and a magnitude of a visual sense variation rate R. In this case, each lateral axis in the characteristic graphs of Figs. 4A and 4B denotes any one of angular velocity AV, distance D from the rotation center, visual sense variation rate R.

In addition, in the first embodiment, display form adjusting section 13 adjusts the contrast on the road map data image. However, as another display form, the brightness, the saturation, and focus of the road map data image may be adjusted.

Fig. 7 shows a display example of the image screen of display 7 when the brightness of road map data image is adjusted. As shown in Fig. 7, with the present position of the vehicle on the image screen of display 7 as the center, as the region of the road map image becomes more remote from the present position of the vehicle on the image screen, the brightness of the road map data image becomes lowered. Even in such a display form as shown in Fig. 7, the troublesome feeling that the vehicular occupant gives when the road map data image is rotated can be avoided in the same manner as described above.

Furthermore, Fig. 8A shows a display example of adjusting the focus of the road map data image by display form adjusting section 13 in such a manner that an adjacent portion of the rotation center on the road map data image is clearly displayed and, as the region of the road map data image becomes more remote from the rotation center, the image becomes shaded. In the case of the display form of adjusting the focus, the troublesome feeling that the vehicular occupant gives during the rotation of the road map data image can be avoided and the visibility of the image screen of display 7 can be improved.

It is noted that Fig. 8B shows a display example on

the display image screen of display 7 in which the contrast of a region of the road map data image which is near to the present position of the vehicle indicated by the arrowed mark is lowered and that of another region thereof which is remote from the center of rotation (arrowed mark position) is raised and Fig. 8C shows a display example on the display image screen of display 7 in which the saturation of the remote region from the position of the arrowed mark is lowered than that of the region near to the arrowed mark position.

In addition, it is possible not only to vary various display forms concentrically (contrast, brightness, saturation, focus, and so forth) with the present position of the vehicle on the road map data image as the center but also to adjust the display form at a desired portion on the road map data image in such a manner as only an upper portion of the display image screen of display 7 or only a lower portion thereof.

In the first preferred embodiment described above, such a series of processes as for a plan view road map data image displayed on the image screen of display 7 has been explained. However, the same series of processes described above are applicable to the road map data image in a form of a bird's eye view (perspective view).

Fig. 9 shows a display example of the bird's eye view displayed on the image screen of display 7. As shown in Fig. 9, the region of the road map data image in the form of the bird's eye view which is near to the present position of the vehicle indicated by the arrowed mark is displayed approximately three-dimensionally. Then, when the traveling direction of the vehicle is changed and the road map data image in the form of the bird's eye view is rotated, the contrast of the region which is remote from the arrowed mark position (the present position of the host vehicle)

is lowered, as shown in Fig. 10. Hence, even in the bird's eye view formed road map data image, the troublesome feeling that the vehicular occupant gives during the rotation of the road map data image can be reduced.

Next, the second preferred embodiment of vehicular display apparatus 1 will be described below.

Fig. 11 shows a block diagram representing the structure of vehicular display apparatus 1 in the second preferred embodiment according to the present invention.

As shown in Fig. 11, an addition of a luminance sensor 23 is a point of difference from vehicular display apparatus 1 in the case of the first embodiment shown in Fig. 2.

Luminance sensor 23 is a sensor to detect a luminance of a surrounding area of the vehicle. In this embodiment, the display form of the road map image data on display 7 is adjusted on the basis of detected data of the luminance sensor 23.

In addition, Fig. 12 shows characteristic graphs representing each relationship between circumferential velocity V1 of the rotating road map data image and a luminance (it is noted that the contrast, the saturation, or focus may be adopted in place of the luminance) of the road map data image displayed on display 7 and which are set in display form setting table 21. Characteristic graphs representing the relationship between the luminance and circumferential velocity V1 are different between that in the case where the surrounding area of the vehicle is bright and that in the case where the surrounding area of the vehicle is dark.

That is to say, when the luminance of the surrounding area of the vehicle is determined to be equal to or larger than a predetermined level, the brightness is set to be varied gradually like the first-order function in the range

of circumferential velocity V1 from 50 to 150 mm/s as shown by a characteristic curve of S1 in Fig. 12. When the luminance of the surrounding area of the vehicle is lower than the predetermined level, the brightness is set to be varied abruptly like the first-order function in the range of circumferential velocity V1 from 50 to 100 mm/s, as shown by another characteristic curve of S2 in Fig. 12.

In the second embodiment described above, in such a case where the luminance of the surrounding area of the vehicle is low as a night time, rainy weather, or run in a tunnel at which the vehicular occupant is particularly easy to feel troublesome, a rate of variation in the brightness with respect to circumferential velocity V1 is set to be large. Hence, the troublesome feeling can be reduced and the visibility of display 7 can be improved. In addition, in such a case where the luminance of the surrounding area is bright as a daytime, the brightness is set to be varied moderately with respect to circumferential velocity V1 so that a required information can accurately be recognized.

Next, the third preferred embodiment of vehicular display apparatus 1 according to the present invention will be described below.

In the third embodiment, the road map data image becomes simplified and displayed as the region of the road map data image becomes more remote from the center of rotation along with the rotation of the road map data image on the image screen of display 7 so that the troublesome feeling that the vehicular occupant gives can be reduced. The structure of the third embodiment is the same as the block diagram shown in Fig. 2 of the first embodiment described above.

The operation of vehicular display apparatus 1 in the third embodiment will be explained with reference to

the block diagram shown in Fig. 2 and an operational flowchart shown in Fig. 13.

First, at a step ST11, present position measuring unit 2 detects a run position of the vehicle. Then, at a step ST12, display controller 6 determines whether the ignition switch is turned off. If No at step ST12, the routine goes to a step ST13. At step ST13, display image data generating section 14 of display controller 6 carries out such a process as to superimpose and display the present position of the vehicle (the arrowed mark) on the region of the road map data stored in road map data storing section 22 which surrounds the point of place at which the vehicle is running.

Next, at a step ST14, velocity calculating section 11 carries out such a process as to derive a turning angle $\theta 1$ of the vehicle within a predetermined period of time on the basis of data on the present position of the vehicle obtained by present position measuring unit 2. Then, at a step ST15, comparing section 12 compares the turning angle $\theta 1$ with the preset reference value θref in the comparing section 12 to determine whether $\theta 1 > \theta ref$. If $\theta 1 > \theta ref$ (Yes) at step ST15, the routine goes to a step ST16. If $\theta 1 \leqq \theta ref$ (No), the routine jumps to step ST12. At step ST16, display form adjusting section 13 carries out such a process as to simplify the road map data image for the region of the road map data image which is equal to or longer than a predetermined distance value from the center of rotation and to display the other region of the road map data image which is shorter than the predetermined distance value from the rotation center normally without the simplification process. Then, at the next step ST17, the generated image data is displayed on the image screen of display 7.

Fig. 14 shows a display example representing an example of the road map data image which has been processed under the simplification process as described in the third embodiment.

As appreciated from Fig. 14, for the region of the road map data image which surrounds the displayed present position of the vehicle (arrowed mark, viz., which provides the center of rotation on the road map data image), the road map data image is displayed normally in details and for the other region of the road map data image which is remote from the center of rotation by the predetermined distance value, the road map data image is simplified and displayed. The meaning of this term of simplified is that the detailed road map information is omitted. Hence, the troublesome feeling that the vehicular occupant gives when the road map data image is rotated can be reduced and the visibility of the image screen on display 7 can be improved.

Next, the fourth preferred embodiment of vehicular display apparatus 1 will be described below.

In the fourth embodiment, along with the rotation of the road map data image on the image screen of display 7, the image before the rotation and that after the rotation are superimposed together and displayed and a ratio of this superimposition is varied gradually so that the road map data image on display 7 is rotated without giving the vehicular occupant the troublesome feeling. The structure of vehicular display apparatus 1 in the fourth embodiment is the same as the block diagram of Fig. 2.

Fig. 15 shows a processing flowchart of the fourth preferred embodiment for explaining the operation of vehicular display apparatus 1 in the fourth embodiment.

At a step ST21, present position measuring unit 2 detects the running position of the vehicle (it is natural

that the traveling direction thereof is measured). At a step ST22, display controller 6 receives the ignition switch position information to determine whether the ignition switch is turned off. If the ignition switch is not turned off (No) at step ST22, the routine goes to a step ST22. If the ignition switch is turned off (Yes) at step ST22, the routine is ended. At step ST23, display image data generating section 14 of display controller 6 carries out such a process as to superimpose the present position of the vehicle (arrowed mark) on the region of the road map data which surrounds the running point of place of the vehicle stored in road map data storing section 22 and displays the arrowed mark superimposed road map data image on the image screen of display 7.

Then, at the next step ST24, velocity calculating section 11 derives the rotation angle $\theta 1$ of the vehicle within the predetermined period of time on the basis of the data on the present position of the vehicle obtained by present position measuring unit 2. Then, the routine goes to a step ST24. At step ST24, comparing section 12 compares reference value θ ref preset in calculating section 12 with rotation angle $\theta 1$ of the vehicle to determine whether $\theta 1 > \theta$ ref. If $\theta 1 > \theta$ ref (Yes) at step ST25, the routine goes to a step ST26. At step ST26, display form adjusting section 13 carries out such a process as to turn a count value of L indicating a level of an image processing to 0 (L = 0). Then, the image of level L is displayed on image screen of level L at the next step ST27.

It is noted that level L is a level indicating a magnitude of the superimposition of two images, when L = 0, the image to be displayed is the whole road map data image before the traveling direction of the vehicle is changed, and, when L = L1, the image to be displayed is

the whole road map data image after the traveling direction of the vehicle is changed. Suppose now that L1 = 5. In this case, when L = 0, an superimposition ratio of the road map data image before the traveling direction of the vehicle is changed to that after the traveling direction thereof is changed is 10 : 0. When L = 1, the same ratio indicates 7 : 3. When L = 2, the same ratio indicates 5 : 5. When L = 3, the same ratio indicates 3 : 7. When L = 4, the same ratio indicates 0 : 10.

Next, at a step ST27, display form adjusting section 13 of display controller 6 carries out such a process as to generate the image of level L (at this time, L = 0). Then, at the next step ST28, the generated road map data image on the image screen of display 7. Thereafter, the value of L is incremented by one (L = L + 1) at a step ST29. The above-described process from step ST27 to step ST29 is repeated until L = L1 at a step ST30. If L = L1 (in this case, L1 = 5) at step ST30 (Yes), the routine jumps to step ST24 and the same series of processes of steps ST24 to ST30 are repeated if $\theta 1 > \theta ref$ at step ST25.

Figs. 16, 17, 18, 19, and 20 show series of display examples of the image screen of display 7 for explaining a variation pattern of the road map data image in the case of the display form adjustment carried out in the fourth embodiment described above. In details, Fig. 16 shows the result of image processing when L = 0 (viz., the superimposition ratio of the road map data image before the rotation thereof to that after the rotation thereof is 10 : 0). Fig. 17 shows the result of image processing when L = 1 (the ratio thereof is 7 : 3). Fig. 18 shows the result of image processing when L = 2 (the same ratio is 5 : 5). Fig. 19 shows the result of image processing when L = 3 (the same ratio is 3 : 7). Fig. 20 shows the result

of processing when L = 4 (the same ratio is 0 : 10).

As appreciated from Figs. 16 through 20, the image is displayed on display 7 in such a manner that the superimposition ratio between two images (image before the rotation thereof and that after the rotation thereof) is gradually varied while the turn of the vehicle is started and, then, the turn of the vehicle is ended.

As described above, in the fourth embodiment of vehicular display apparatus 1 according to the present invention, when the traveling direction of the vehicle is changed, the superimposition between the road map data image before and after this direction change is carried out and the superimposition ratio is set to be gradually varied. Therefore, the vehicular occupant can visually recognize the road map data image displayed on display 7 with a pleasant feeling. Consequently, the troublesome feeling that the vehicular occupant gives can be relieved.

Next, the fifth preferred embodiment of vehicular display apparatus 1 will be described below.

In the fifth embodiment, such a process as to rotate the road map data image is carried out in such a manner as to synchronize the rotation of the road map data image displayed on the image screen of display 7 with a variation of a field of view for a vehicular forward zone of the vehicle that the vehicular occupant visually recognizes.

Hence, the road map data image can be displayed without giving an unpleasant feeling to the vehicular occupant. The structure of vehicular display apparatus 1 in the fifth embodiment has the same structure as the block diagram of Fig. 1 described above.

Fig. 21 shows a processing flowchart carried out in the fifth embodiment.

The operation of the fifth embodiment will be

described with reference to Fig. 21.

In Fig. 21, display controller 6 determines whether the ignition switch of the vehicle is turned off at a step ST31. At a step ST32, the present position measuring unit 2 measures the present position of the vehicle and traveling direction thereof.

At a step ST33, display controller 6 superimposes the arrowed mark representing the present position of the vehicle and direction thereof on the region of the road map data image which surrounds the running position of the vehicle and generates the image synthesized with character data representing a name of place or so forth. Then, at the next step ST34, the display controller 6 carries out such a process as to display the generated image on display 7.

Next, at a step ST35, display controller 6 carries out such a process as to calculate the traveling direction (vehicular direction) of the vehicle on the basis of the data on the traveling direction of the vehicle obtained by gyro sensor 4. At a step ST36, display controller 6 determines whether a magnitude of the turning angle $\Delta\theta$ of the vehicle for a predetermined period of time is larger (wider) than reference value θref preset in calculating section 12. If $|\Delta\theta| > \theta$ref (Yes) at step ST36, the routine goes to a step ST37. At step ST37, display controller 6 carries out such a process as to rotate the road map data image displayed on display 7 by the angle of $\Delta\theta$ in a reverse direction to the turning direction of the vehicle.

At this time, since the turning angle is measured on the basis of the data derived by gyro sensor 4, the display image onto display 7 can be generated at an earlier timing than such as a process as to read a new road map data image and as to synthesize the characters. Hence, the road map

data image can be rotated in synchronization with the turn of the vehicle.

Then, the image treated under the image processing is added with the process of varying appropriately the image contrast, brightness, saturation, and focus during the rotation of the road map data image and, thereafter, the image processed road map data image is displayed on the image screen of display 7 at steps ST38 and ST39.

As described above, in the fifth embodiment, when the traveling direction of the vehicle is changed, the rotation of the road map data image to be displayed on display 7 is synchronized with the field of view for the actual vehicular forward zone that the vehicular occupant visually recognizes. The vehicular occupant can visually recognize the road map data image displayed on display 7 without giving the unpleasant feeling.

Next, the sixth preferred embodiment of vehicular display apparatus 1 according to the present invention will be described below.

In the sixth embodiment, it is possible to adjust the rotation of the road map data image to be displayed on display 7 on the basis of a predicted data derived according to a result of such a prediction as a traveling route of the vehicle.

Fig. 22 shows a block diagram representing the structure of vehicular display apparatus in the sixth preferred embodiment.

As appreciated from Fig. 22, vehicular velocity display apparatus 1 includes: present position measuring unit 2, GPS antenna 3, gyro sensor 4, distance sensor 5, display controller 6, and display 7 in the same way as the vehicular display apparatus shown in Fig. 1. In the sixth embodiment, a winker sensor 31 to detect a drive state of

an winker of the vehicle and a vehicular velocity sensor 32 to detect a velocity of the vehicle.

The operation of vehicular display apparatus 1 in the sixth preferred embodiment will be described with reference to a series of operational flowcharts shown in Figs. 23 through 25.

Present position measuring unit 2 shown in Fig. 22 measures the position of the vehicle on the basis of data obtained from the measuring satellites through GPS antenna 3 and the data of the traveling direction and running distance of the vehicle obtained from gyro sensor 4 and distance sensor 5.

Next, when the vehicular driver inputs a destination to which the vehicle is to be reached on display controller 6 at a step ST52. At a step ST53, display controller 6 carries out such a process as to calculate a guide route to guide the vehicle from the present position to the destination.

Then, the image display processing is carried out with a count value N set as N = 0 at a step ST54, the count value N representing a level of the image processing. Then, at a step ST55, the image processing of level of N = 0 is carried out and the image processed road map data image is displayed. It is noted that the display image, at this time, is M0.

Next, a timer (not shown) provided within display controller 6 is reset at a step ST56. The present time T is set as T = 0. Display controller 6 determines whether the winker of the vehicle is presently operated at a step ST57 from a signal of winker sensor 31. If the winker is being operated (Yes at step ST57), the routine goes to a step ST58. At step ST58, display controller 6 determines whether a traffic intersection is present in the traveling direction of the vehicle on the basis of data on the guide

route. If the traffic intersection is present (Yes at step ST58), the routine goes to a step ST59. Display controller 6 carries out such a process as to estimate a road to which the vehicle turns right or left.

Next, at a step ST60, display controller 6 estimates the position of the vehicle and direction thereof at a future time T1 after an elapse of a predetermined period of time from the present time. At a step ST61, display controller 6 carries out such a process as to derive the road map data image at the time of T1. It is noted that the level of image processing at a time T1 is N1 and the image to be displayed on display 7 is M1.

Display controller 6 compares road map data image M0 displayed on display 7 with road map data image M1 at a future time T1 (step ST62). When the vehicle is turned at an ordinary velocity, display controller 6 determines whether a position of the road map data image at which the corresponding circumferential velocity V1 of road map data image is larger than reference value Vref (for example, Vref = 50 mm/s) at a step ST63.

Consequently, if display controller 6 determines that the position of the road map data image at which circumferential velocity V1 is larger than reference value Vref (No) at step ST63 is present, the routine goes to a step ST64. At step ST64, display controller 6 determines whether image processing level N is 0 (N = 0). In this case, since N = 0 (Yes at a step ST64), the routine jumps to a step ST73. At step ST73, display controller 6 carries out such a process as to display image M1 at a time point at which the present time T has reached to the time T1. Thus, display controller 6 calculates the present position and traveling direction of the vehicle at a step ST75. If an engine of the vehicle is turned off (No at a step ST76),

then, the processing is repeated from a step ST56. That is to say, if circumferential velocity V1 on a future road map data image is smaller than reference value Vref, display controller 7 does not carry out such a process as to variably modify the display form such as the image contrast but carries out such a process as to display image M1 corresponding to a time point at which it reaches to time point T1.

On the other hand, it is predicted that the position of the road map data image at which circumferential velocity V1 of road map data image is larger than reference value Vref (V1 > Vref at step ST63), the routine goes to a step ST68. At step ST68, if image processing level N has reached to image processing level N1 at time point T1 (Yes at step ST68), the routine goes to a step ST72. At step ST72, such a process as to add display image M1 at time point T1 to image processing level N1 is carried out.

Thereafter, when the time has reached to T1 (Yes at step ST73), display controller 6 displays display image M1 on display 7 at a step ST74. At a step ST75, display controller 6 calculates the present position and traveling direction of the vehicle. Unless the engine is turned off (No at step ST76), the routine jumps to and returns to step ST56.

In this state, since the time has reached to T1 and the vehicle has ended to turn the intersection, No is an answer at step ST63. If No at step ST63, the routine goes to step ST64. Since, at this time, image processing level " N " is N = N1 (No at step ST64), the routine goes to a step ST65. At step ST65, image processing level is decremented by one (N = N - 1). Then, at a step ST66, such an image processing as contrast adjustment is carried out. At the next step ST67, the image display is carried out. Then, at a time point at which image processing level "

N " is N = 0, the road map data image at the time point T1 (newly set time T1) is displayed (step ST74). In addition, if the engine is turned off (Yes at a step ST76), the processing shown in Figs. 23, 24, and 25 is ended.

As described above, in a case where at future time point T1, it is predicted that the position on the road map data image at which corresponding circumferential velocity V1 of road map data image is larger than reference value Vref, such a process can be carried out as to relieve the troublesome feeling given to the vehicular occupant by previously adjusting the contrast, brightness, and focus on the road map data image before the time has reached to time t1. The road map data image displayed on display 7 can be modified in more natural sense of feeling. Consequently, the visibility of the image screen of display 7 for the vehicular driver can remarkably be improved.

In vehicular display apparatus in the sixth embodiment described above, the guide route can be derived from the present position of the vehicle and from the data on the destination and winker sensor 31 and vehicular velocity sensor 32 can be used to estimate whether the vehicle is to turn the intersection at a future time T1.

Therefore, both of timings at which the vehicle has turned in response to the steering operation by the vehicular driver and at which the road map data image on display 7 can appropriately be adjusted.

Figs. 26A, 26B, 26C, and 26D show explanatory views representing rotational timings of the vehicular turn and road map data image.

Fig. 26A shows a timing chart representing a vehicular turn and rotation timing of rotation of road map data image.

Figs. 26B, 26C, and 26D are timing charts representing various timing charts representing various timing patterns

when the road map data image is rotated.

As shown in Figs. 26A, the vehicle starts the turning at a time point of t1 and ends the turning at a time point of t2. In the example shown in Fig. 26B, the timings of the rotation start and rotation end are synchronized with the turning of the vehicle. In addition, the image processing is added to the road map data image at a time R1 immediately before the start of rotation on the road map data image and the contrast adjustment and brightness adjustment are carried out. At a time R2 immediately after the end of rotation, the contrast and brightness are returned to original states.

In the example of Fig. 26C, the start timing of rotation of the road map data image is synchronized with the turn of the vehicle and the image processing is added to the road map data image at a time R3 immediately before the start of the turning (rotation) of the road map image. In addition, at a time point of t3 slightly immediately before the time point t2 which is a time point at which the turn of the vehicle is ended, the rotation of the road map data image is ended. At a time R4, the road map data image under the image processing is returned to the original state.

In the example of Fig. 26D, the image processing is started synchronizing the time point t1 at which the turn of the vehicle is started and, after the elapse of the time R5, the road map data image is rotated. In addition, such a process as to return the road map data image to the original state is carried out at the time point t2 at which the turn of the vehicle is ended.

Then, as shown in Fig. 26B, in a case where the timing at which the start of turn of the vehicle is made coincident with that at which the start of rotation of the road map

data image and that at which the turn of the vehicle is ended made coincident with that at which the end of rotation of the road map is ended, respectively, the turn of the vehicle is made coincident with the rotation of the road map data image. Thus, the unpleasant feeling that the vehicular occupant gives is reduced and it is suitable when the traveling direction of the vehicle is varied along the path.

In addition, since, in the case of Fig. 26C, the road map data image is switched to the display for a straight run at a time point at which the turning of the vehicle is substantially ended in such a case when the vehicle turns right or left on the traffic intersection. Hence, it becomes possible for the vehicular driver to anticipate the subsequent traveling direction. Consequently, the display method shown in Fig. 26C is suitable when the vehicle turns left or right at the traffic intersection. In either the case of Fig. 26D or Fig. 26C, the display image on display is changed to that used for the rotation there of and road map information quantity on the display image is reduced. Hence, the vehicular driver's attention is not paid to the displayed image on display 7 more than necessary. Consequently, a driving safety at the vehicular run on any traffic intersection can be improved. It is noted that, in the case of Fig. 26D, the display of road map data image is switched in synchronization with the actual start or end of the turn of the vehicle. Hence, it is unnecessary to predict the future traveling direction of the vehicle.

The entire contents of Japanese Patent Application No. 2000-346694 (filed in Japan on November 14, 2000) are herein incorporated by reference.

Modifications and variations of the embodiments described above will occur to those skilled in the art in

the light of the above teachings. The scope of the invention is defined with reference to the following claims.

INDUSTRIAL APPLICABILITY:

The present invention relates to the display apparatus and method for the automotive vehicle such as, so-called, car navigation system and method, in which the road map data image which meets the vehicular driver's drive feeling of the vehicle can be displayed and the visibility of display can be improved. Basically, in the vehicular display apparatus according to the present invention, when the road map data image is rotated along with the turn of the vehicle on the image screen of display, the display form is modified in such a manner that the display form on the region of the road map data image which is near to the displayed present position of the vehicle is made different from that on the other region thereof which is remote from the displayed present position of the vehicle.

CLAIMS

1. A display apparatus for an automotive vehicle, comprising:

an image display section;

a present position measuring section that measures a present position of the vehicle;

a road map storing section that stores a road map data image;

a superimpose processing section that superimposes a mark representing the present position of the vehicle on the road map data image to display the road map data image on which the mark is superimposed through the image display section; and

display control section that rotates the road map data image displayed on an image screen of the image display section in accordance with a traveling direction of the vehicle and varies a display form of the displayed road map data image between a region of the road map data image which is near to a displayed position at which the vehicle is present and another region of the road map data image which is remote from the displayed position thereof when rotating the road map data image on the image screen displayed on the image display section.

2. A display apparatus for an automotive vehicle, comprising:

an image display section;

a present position measuring section that measures a present position of the vehicle;

a road map storing section that stores a road map data image;

a superimpose processing section that superimposes

a mark representing the present position of the vehicle on the road map data image to display the road map image on which the mark is superimposed through the image display section; and

a display control section that rotates the road map data image displayed on an image screen of the image display section in accordance with a traveling direction of the vehicle and displays a region of the road map data image which is near to a displayed position at which the vehicle is present in a display form of a video image clearer than another region of the road map data image which is remote from the displayed position thereof, when rotating the road map data image on the image screen displayed on the image display section.

3. A display apparatus for an automotive vehicle, comprising:

an image display section;

a present position measuring section that measures a present position of the vehicle;

a road map storing section that stores a road map image;

a superimpose processing section that superimposes a mark representing the present position of the vehicle on the road map data image to display the road map data image through the image display section; and

a display control section that rotates the road map data image displayed on an image screen of the image display section in accordance with a traveling direction of the vehicle and controls an image displayed on the image display section, the display control section comprising: velocity calculating section that calculates one of a circumferential velocity thereof at least one given spot of place on the

displayed image screen and an angular velocity thereof on the basis of a turning velocity of the vehicle detected by the present vehicle position measuring section and a display magnification displayed on the image screen of the image display section; and a display form adjusting section that adjusts a display form of the displayed image screen of the image display section according to a magnitude of at least one of the circumferential velocity and the angular velocity calculated by the velocity calculating section.

4. A display apparatus for an automotive vehicle, as claimed in claim 1, further comprising a display form setting table storing a variation characteristic of the display form and wherein the display control section adjustably varies the display form on the image screen of the image display section on the basis of the variation characteristic preset in the display form setting table.

5. A display apparatus for an automotive vehicle, as claimed in claim 4, wherein the variation characteristic in the display form setting table is preset with any one of the angular velocity, circumferential velocity, a distance from a center of the rotation of the road map data image and a visual sense variation rate as a parameter.

6. A display apparatus for an automotive vehicle, as claimed in claim 1, wherein the display form is at least one of image contrast, brightness, saturation, and focus.

7. A display apparatus for an automotive vehicle, as claimed in claim 1, wherein, when rotating the road map data image displayed on the image screen of the image display section, the display control section controllably displays

the road map data image on the image screen of the image display section in such a manner that contents of the road map data image in the region of the road map data image which is near to the displayed position at which the vehicle is present are displayed in details and the contents thereof in the other region thereof which is remote from the position thereat are displayed in a simplification form.

8. A display apparatus for an automotive vehicle, as claimed in claim 7, wherein the display control section determines whether the other region of the road map data image is to be displayed in the simplification form with any one of an angular velocity of the rotating road map data image, a circumferential velocity of at least a given spot on the other region, a distance of the given spot from a rotation center thereof, and a visual sense variation rate as a parameter.

9. A display apparatus for an automotive vehicle, as claimed in claim 1, wherein the display control section varies the display form in such a manner as to superimpose the road map data image after the traveling direction of the vehicle is changed on that before the traveling direction of the vehicle is changed when the direction of the vehicle is changed to rotate the road map data image and to vary gradually a superimposition ratio of the road map data image after the traveling direction of the vehicle is changed to the road map image data before the road map data image is changed as the time has passed from 10 : 0 to 0 : 10.

10. A display apparatus for an automotive vehicle, as claimed in claim 1, wherein the display control section varies the display form in such a manner as to synchronize

a rotation of a field of view in a driving direction of the vehicle with that of the road map image data for the road map image to be displayed on the image screen of the road map data image.

11. A display apparatus for an automotive vehicle, as claimed in claim 1, wherein the display control section comprises a vehicular traveling route direction predicting section that predicts a direction of a traveling route of the vehicle and wherein, when the direction of the traveling route of the vehicle is varied through an angle equal to or wider than a predetermined angle, the display control section rotates the road map data image with the image of the vehicle as a center on the basis of a predicted data on the direction of the traveling route of the vehicle varied through an angle equal to or wider than the predetermined angle.

12. A display apparatus for an automotive vehicle, as claimed in claim 11, wherein the vehicular traveling route direction predicting section predicts the direction of the forwarding route of the vehicle on the basis of at least one of the following data: (a) a comparison data comparing the present traveling direction of the vehicle read from the road map data image with a forward bend situation of the present traveling direction; (b) a data on a preset guide route; and (c) a data on a winker operation of the vehicle.

13. A display apparatus for an automotive vehicle, as claimed in claim 11, wherein the display control section varies the display form of the displayed image screen at an earlier timing than a turning start timing of the vehicle.

14. A display apparatus for an automotive vehicle, as claimed in claim 11, wherein the display control section returns the display form of the displayed image screen on the image display section to an original state at a time point earlier than a timing at which the vehicle has ended a turning.

15. A display apparatus for an automotive vehicle, as claimed in claim 11, wherein the display control section varies the display form of the displayed road map data image on the image screen of the image display section after a timing at which the vehicle starts to turn and returns the varied display form to the original state after a timing at which the vehicle has ended the turning.

16. A display apparatus for an automotive vehicle, comprising:

image display means;

present position measuring means for measuring a present position of the vehicle;

road map storing means for storing a road map data image;

superimpose processing means for superimposing a mark representing the present position of the vehicle on the road map image to display the road map data image on which the mark is superimposed through the image display section; and

display control means for rotating the road map data image displayed on an image screen of the image display section in accordance with a traveling direction of the vehicle and for varying a display form of the displayed road map data image between a region of the road map data

image which is near to a displayed position at which the vehicle is present and another region of the road map data image which is remote from the displayed position thereof when rotating the road map data image on the image screen displayed on the image display section.

17. A display method for an automotive vehicle, comprising:

providing an image display section;

measuring a present position of the vehicle;

storing a road map data image;

superimposing a mark representing the present position of the vehicle on the road map data image to display the road map data image on which the mark is superimposed through the image display section;

rotating the road map data image on an image screen of the image display section in accordance with a traveling direction of the vehicle while displaying the road map data image on an image screen of the image display section; and

varying a display form of the displayed road map data image between a region of the road map data image which is near to a displayed position at which the vehicle is present and another region of the road map data image which is remote from the displayed position thereof while rotating the road map data image on the image screen of the image display section.

18. A display apparatus for an automotive vehicle, as claimed in claim 2, wherein the display control section varies the display form in such a manner as to synchronize a rotation of a field of view in a traveling direction of the vehicle with that of the road map image data for the road map image to be displayed on the image screen of the

road map data image.

19. A display apparatus for an automotive vehicle, as claimed in claim 3, wherein the display control section comprises a vehicular traveling route direction predicting section that predicts a direction of a traveling route of the vehicle and wherein, when the direction of the traveling route of the vehicle is varied through an angle equal to or wider than a predetermined angle, the display control section rotates and displays the road map data image with the image of the vehicle as a center on the basis of a predicted data on the direction of the traveling route of the vehicle varied through an angle equal to or wider than the predetermined angle.

FIG.1

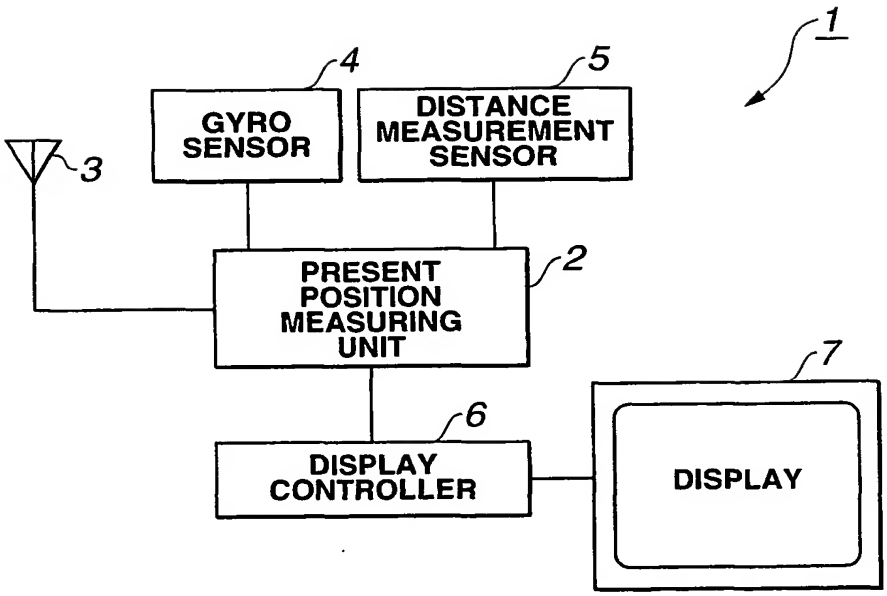

1
4
5
GYRO SENSOR
DISTANCE MEASUREMENT SENSOR
3
PRESENT POSITION MEASURING UNIT
2
7
6
DISPLAY CONTROLLER
DISPLAY

FIG.2

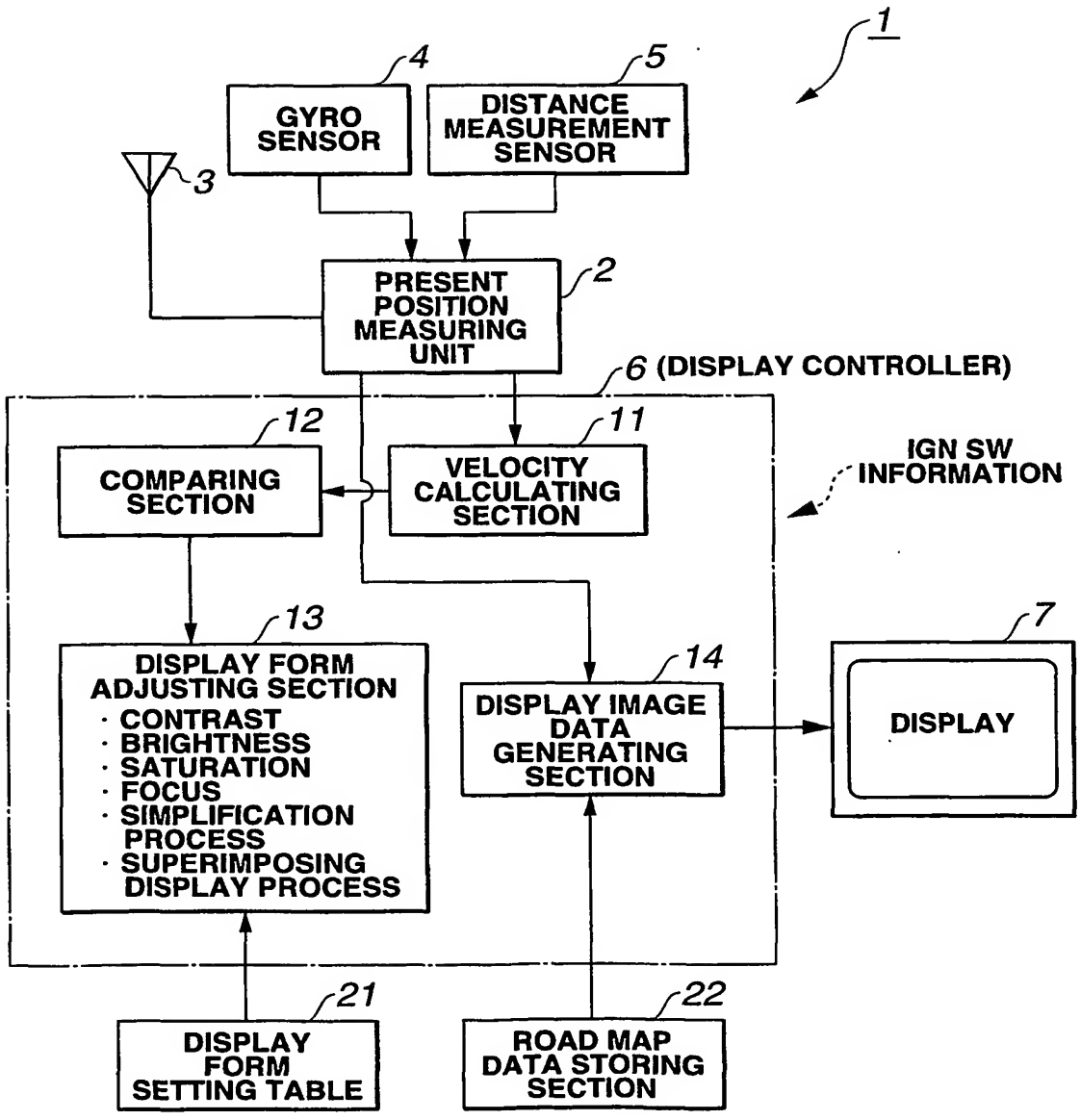

1
4
5
GYRO SENSOR
DISTANCE MEASUREMENT SENSOR
3
2
PRESENT POSITION MEASURING UNIT
6 (DISPLAY CONTROLLER)
12
11
COMPARING SECTION
VELOCITY CALCULATING SECTION
IGN SW INFORMATION
13
DISPLAY FORM ADJUSTING SECTION
· CONTRAST
· BRIGHTNESS
· SATURATION
· FOCUS
· SIMPLIFICATION PROCESS
· SUPERIMPOSING DISPLAY PROCESS
14
DISPLAY IMAGE DATA GENERATING SECTION
7
DISPLAY
21
22
DISPLAY FORM SETTING TABLE
ROAD MAP DATA STORING SECTION

FIG.3

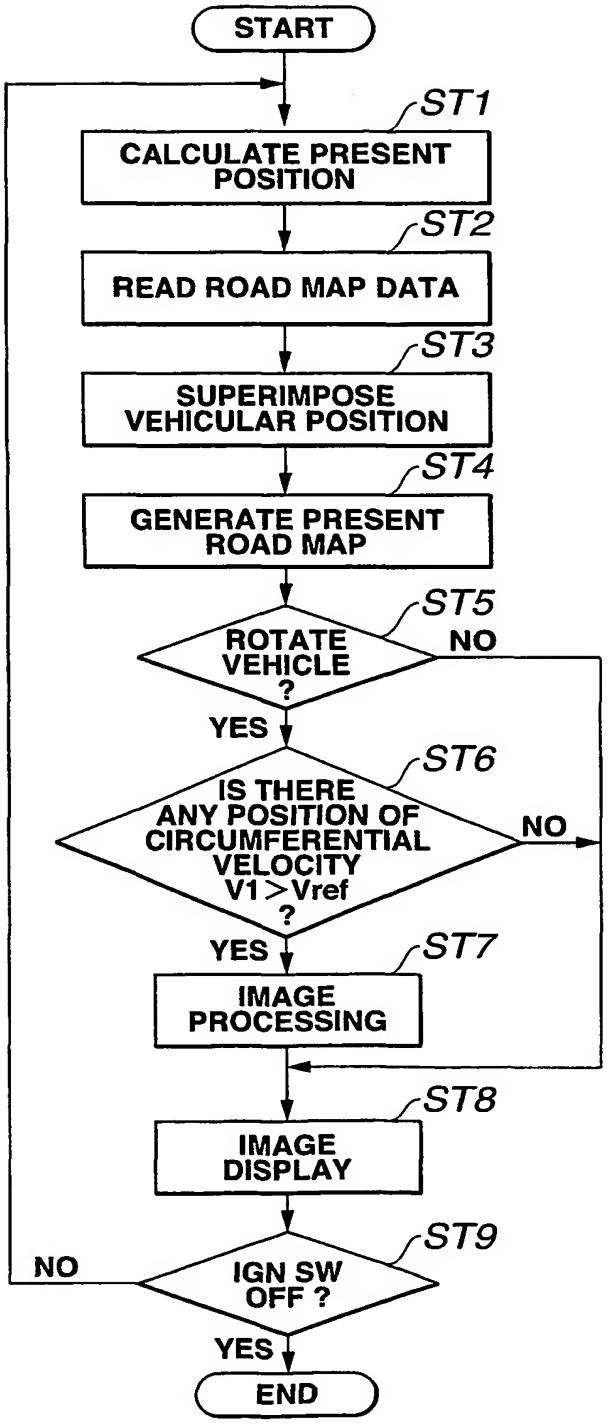

START
ST1
CALCULATE PRESENT POSITION
ST2
READ ROAD MAP DATA
ST3
SUPERIMPOSE VEHICULAR POSITION
ST4
GENERATE PRESENT ROAD MAP
ST5
ROTATE VEHICLE ?
NO
YES
ST6
IS THERE ANY POSITION OF CIRCUMFERENTIAL VELOCITY V1 > Vref ?
NO
YES
ST7
IMAGE PROCESSING
ST8
IMAGE DISPLAY
ST9
IGN SW OFF ?
NO
YES
END

FIG.4A

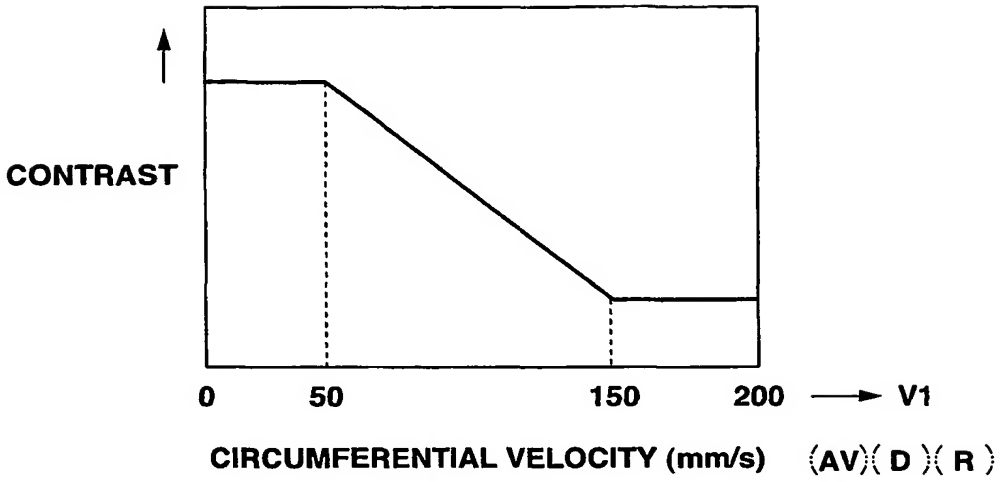

CONTRAST
0
50
150
200
V1
CIRCUMFERENTIAL VELOCITY (mm/s)
(AV)(D)(R)

FIG.4B

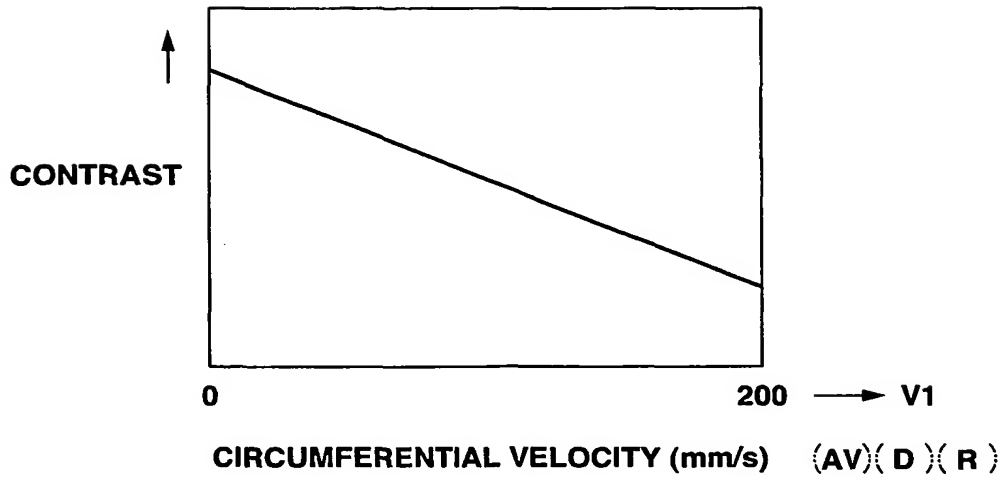

CONTRAST
0
200
V1
CIRCUMFERENTIAL VELOCITY (mm/s)
(AV)(D)(R)

FIG.5

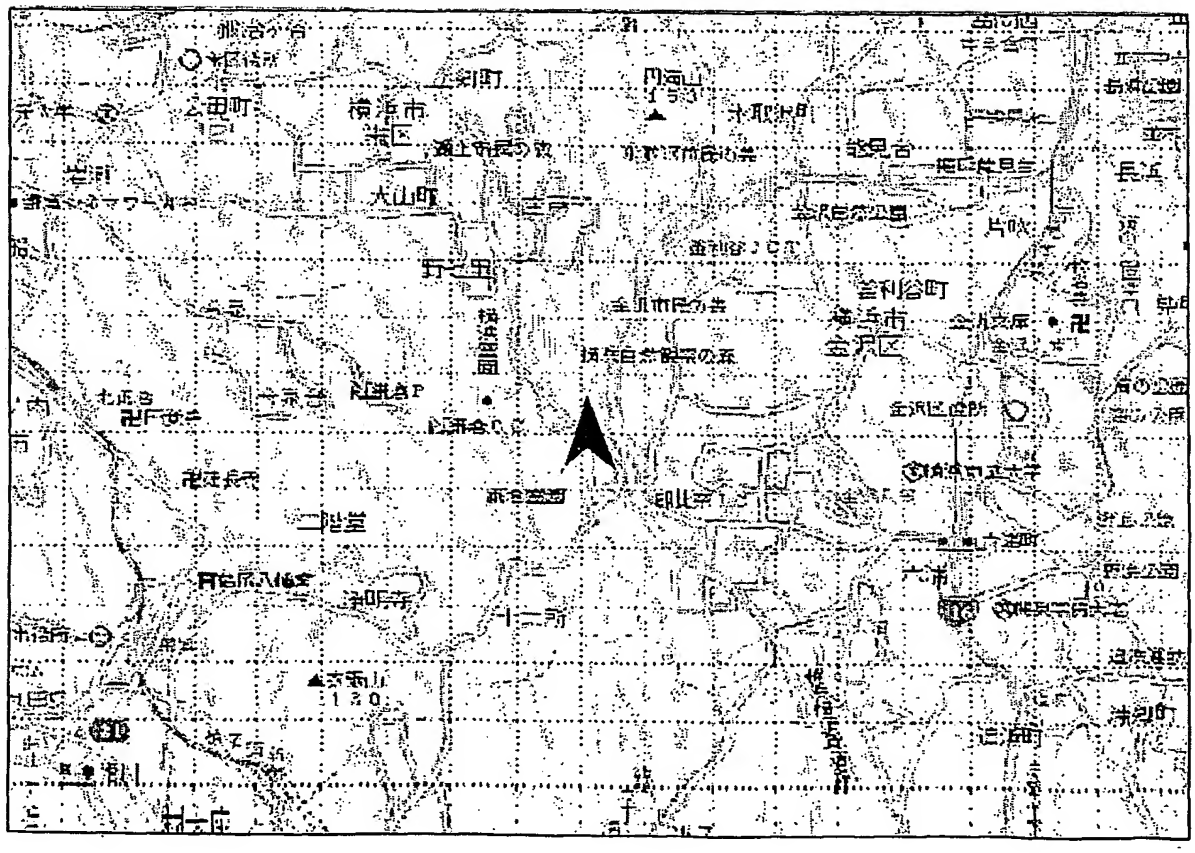


FIG.6

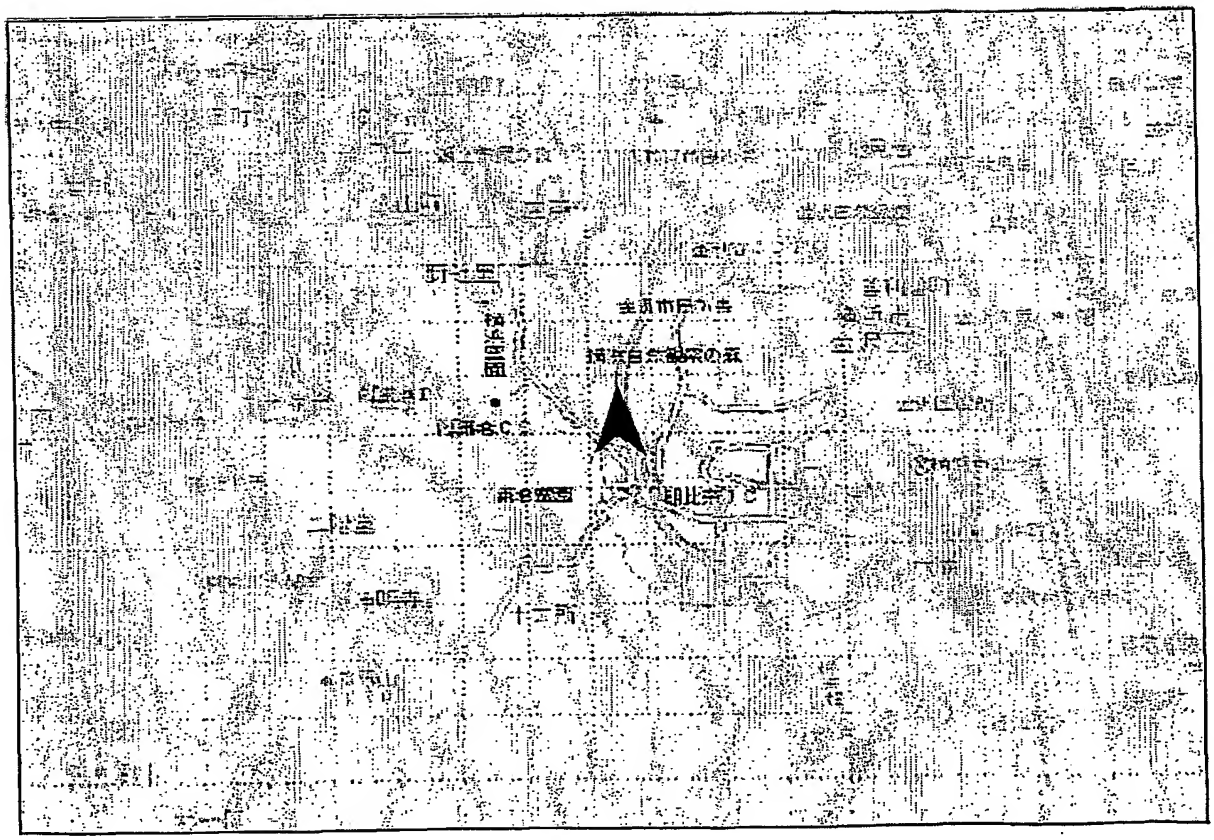


FIG.7

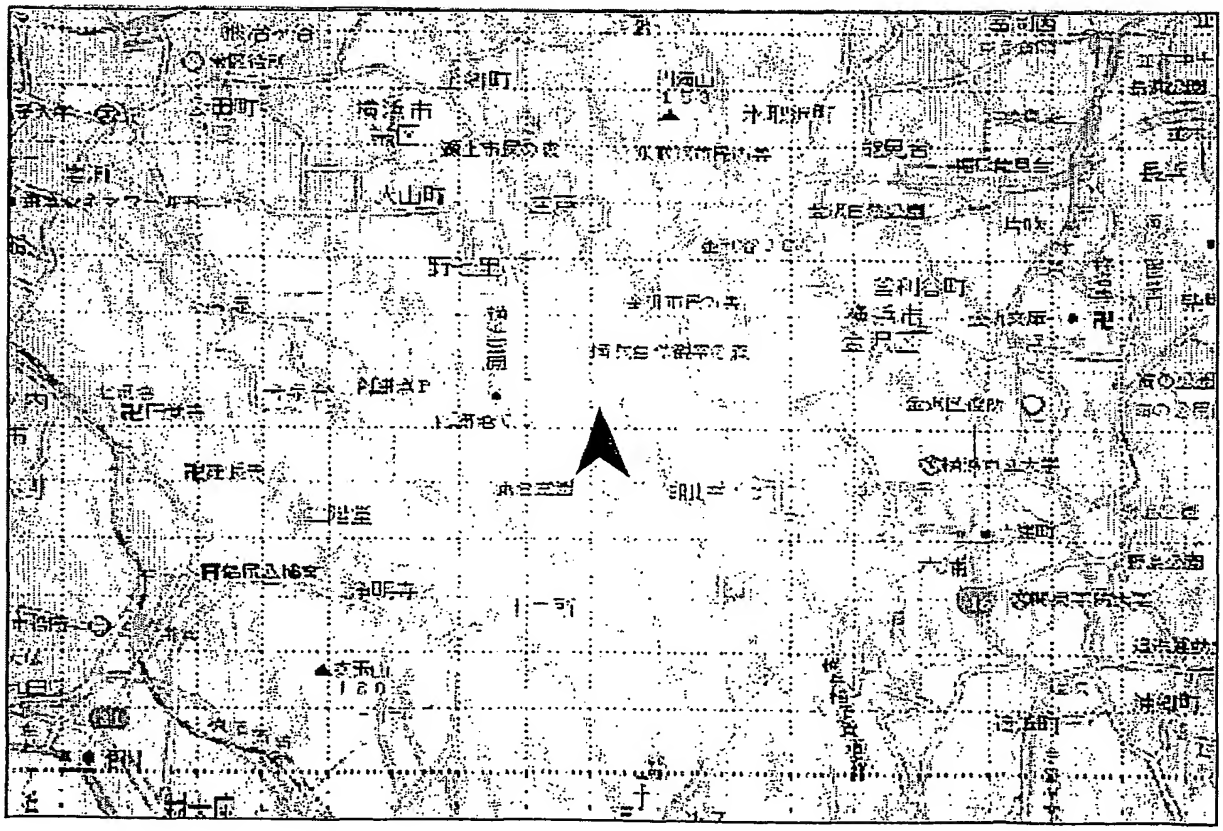


FIG.8A

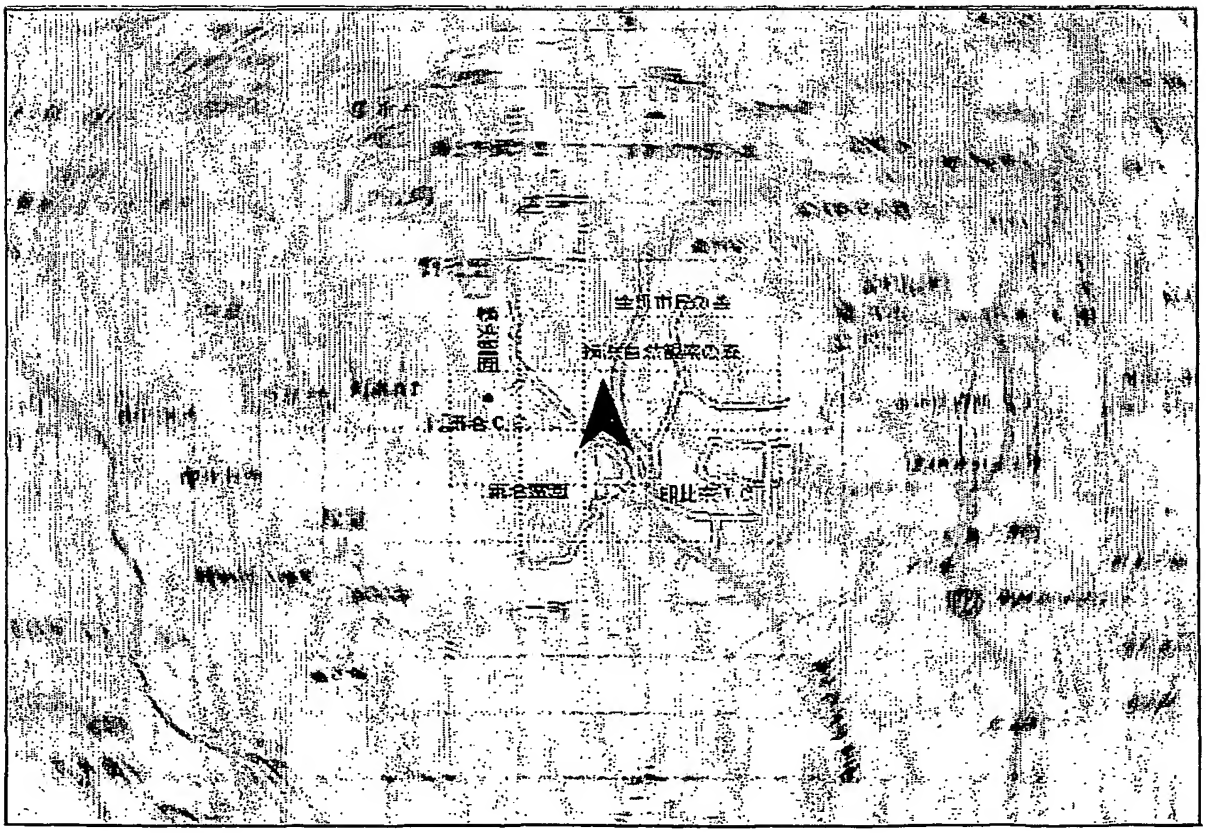


FIG.8B

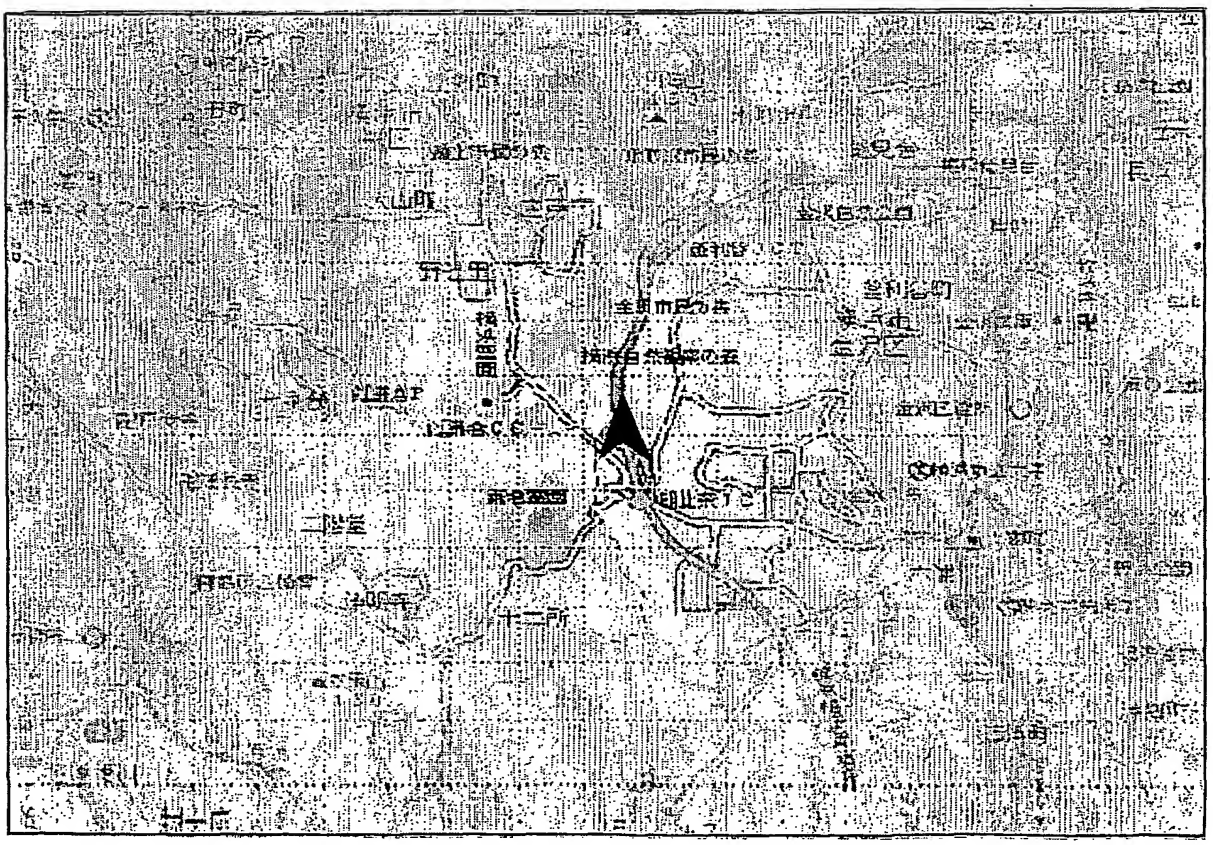


FIG.8C

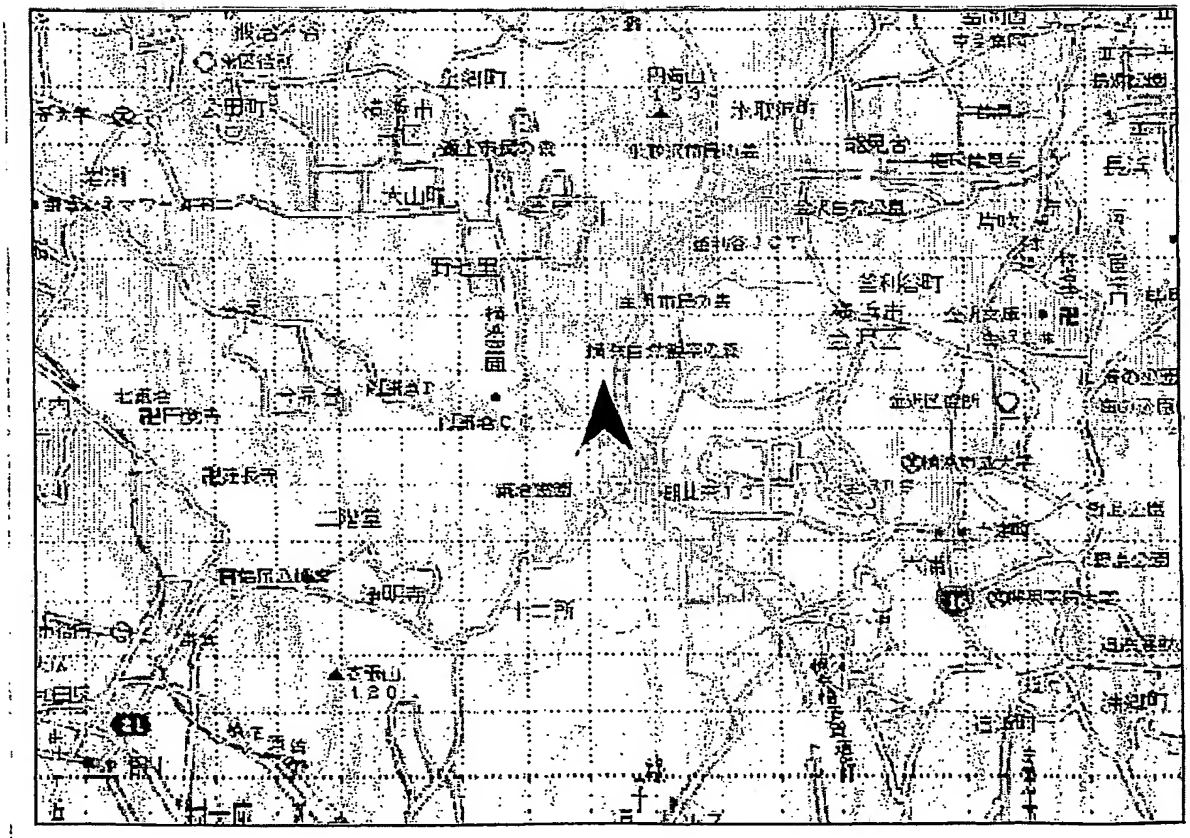


FIG.9

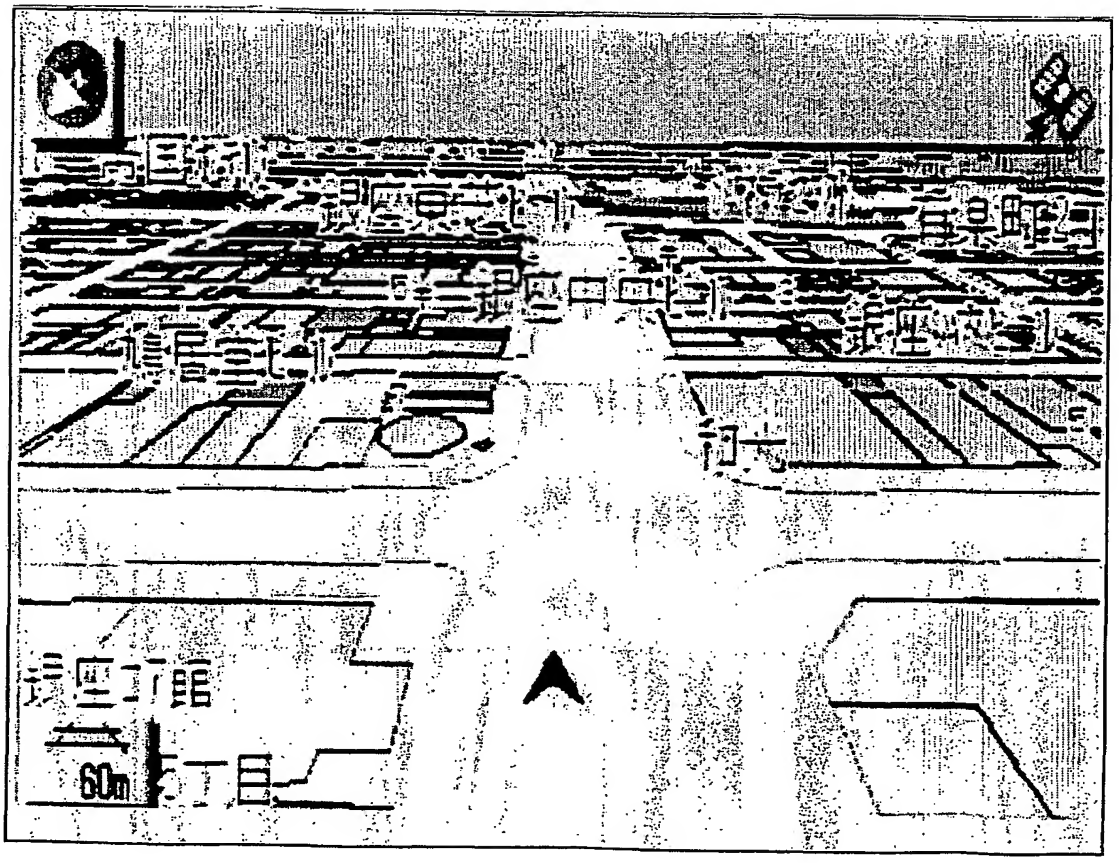


FIG.10

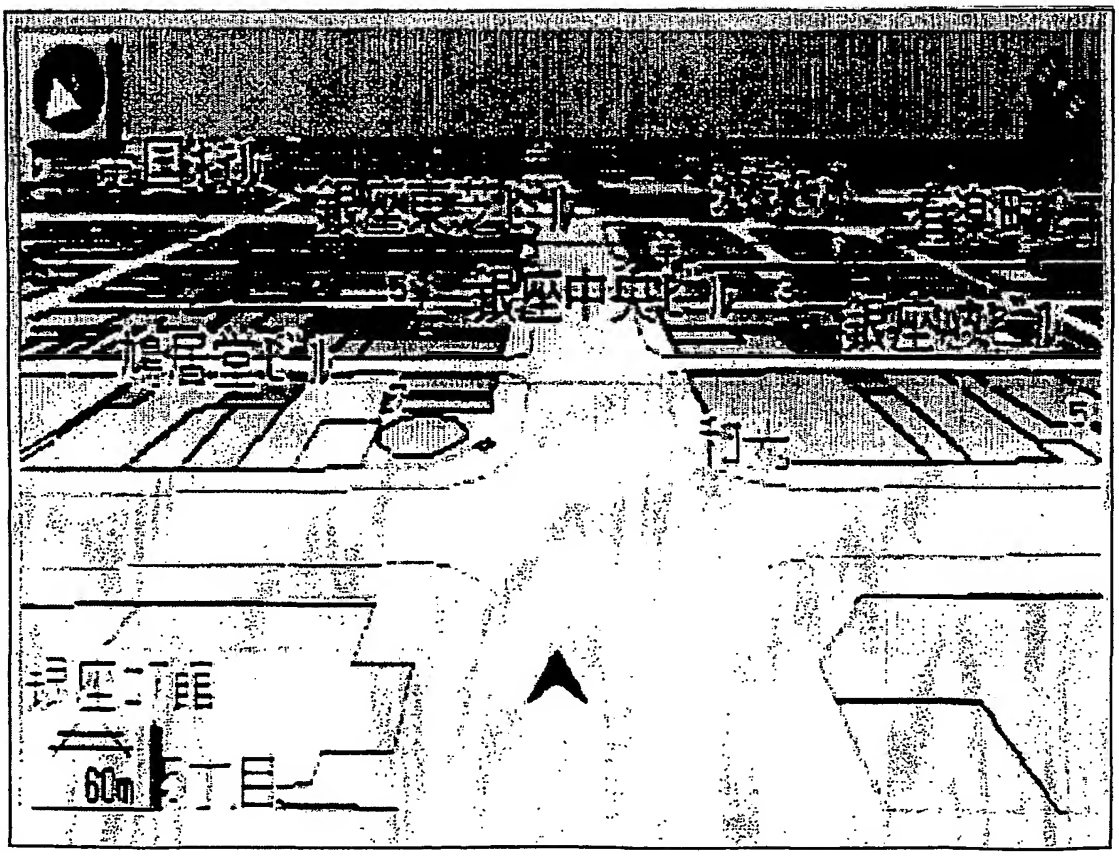


FIG.11

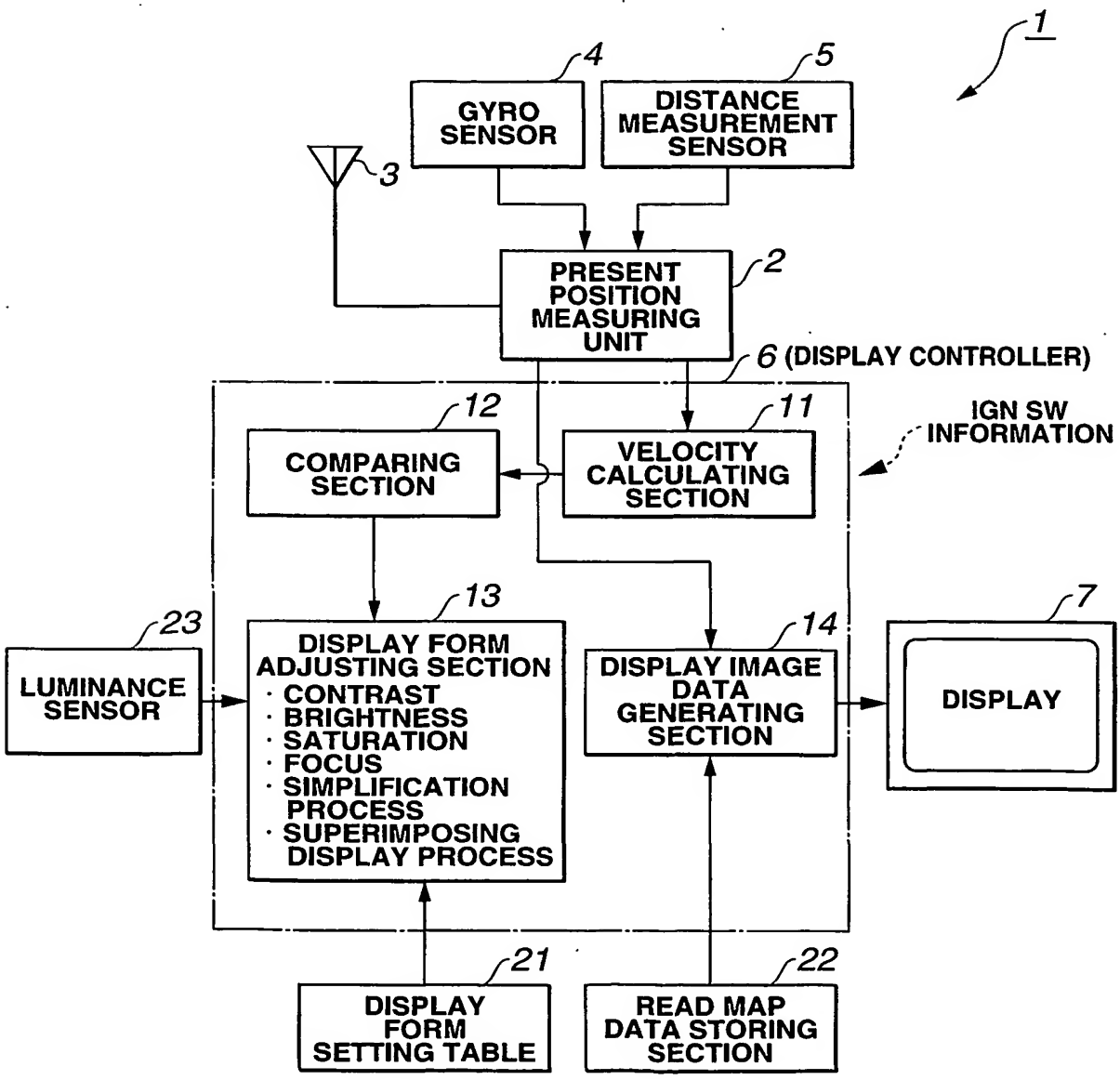

1
4
GYRO SENSOR
5
DISTANCE MEASUREMENT SENSOR
3
PRESENT POSITION MEASURING UNIT
2
6 (DISPLAY CONTROLLER)
12
COMPARING SECTION
11
VELOCITY CALCULATING SECTION
IGN SW INFORMATION
23
LUMINANCE SENSOR
13
DISPLAY FORM ADJUSTING SECTION
· CONTRAST
· BRIGHTNESS
· SATURATION
· FOCUS
· SIMPLIFICATION PROCESS
· SUPERIMPOSING DISPLAY PROCESS
14
DISPLAY IMAGE DATA GENERATING SECTION
7
DISPLAY
21
DISPLAY FORM SETTING TABLE
22
READ MAP DATA STORING SECTION

FIG.12

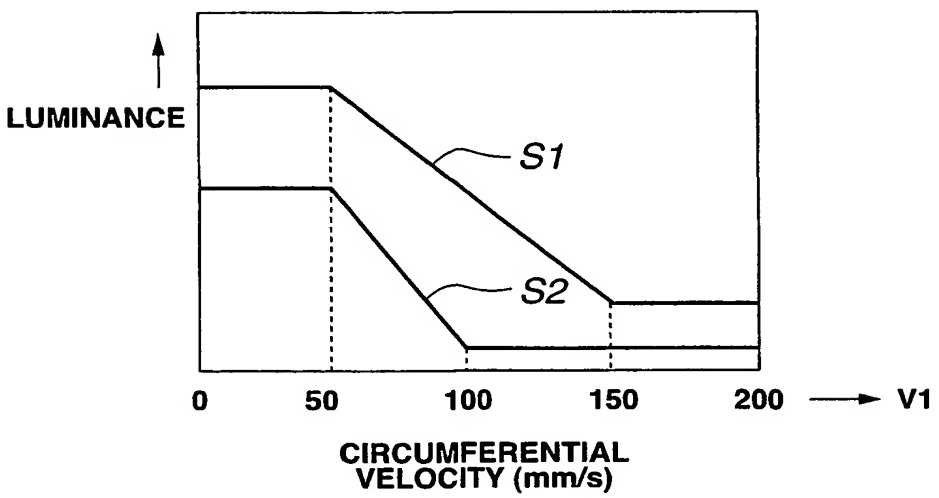

LUMINANCE
S1
S2
0
50
100
150
200
V1
CIRCUMFERENTIAL VELOCITY (mm/s)

FIG.13

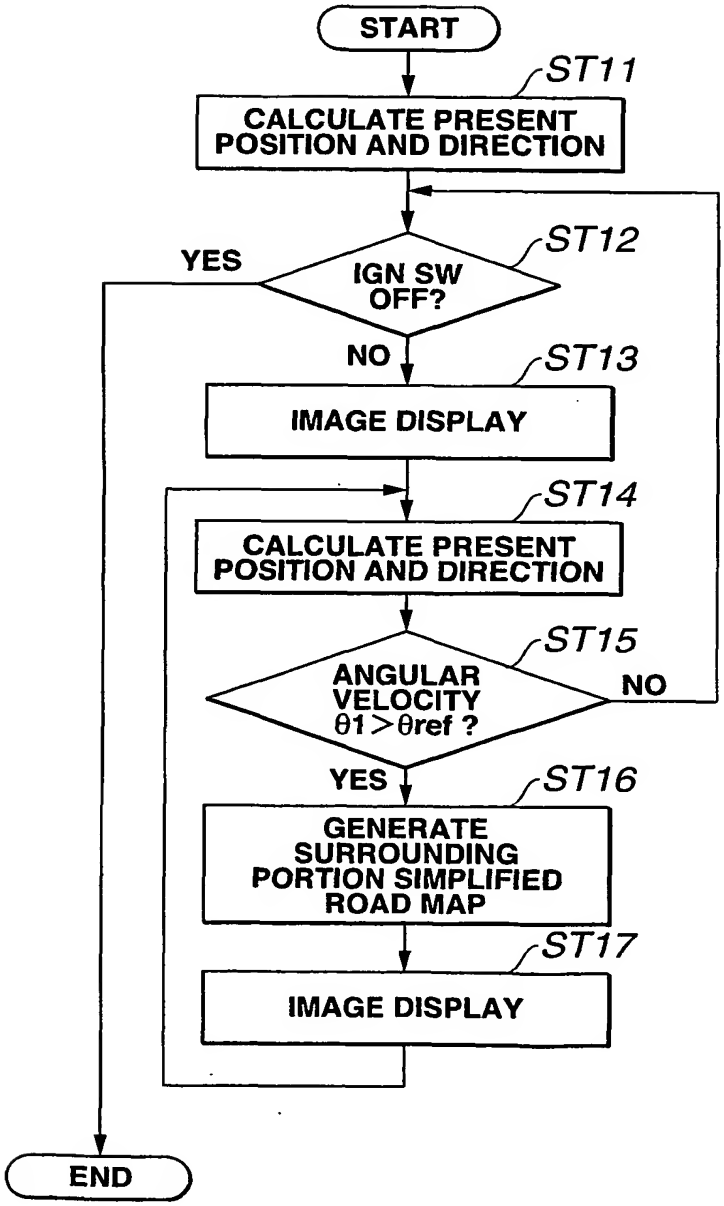

START
ST11
CALCULATE PRESENT POSITION AND DIRECTION
ST12
YES
IGN SW OFF?
NO
ST13
IMAGE DISPLAY
ST14
CALCULATE PRESENT POSITION AND DIRECTION
ST15
ANGULAR VELOCITY θ1 > θref ?
NO
YES
ST16
GENERATE SURROUNDING PORTION SIMPLIFIED ROAD MAP
ST17
IMAGE DISPLAY
END

FIG.14

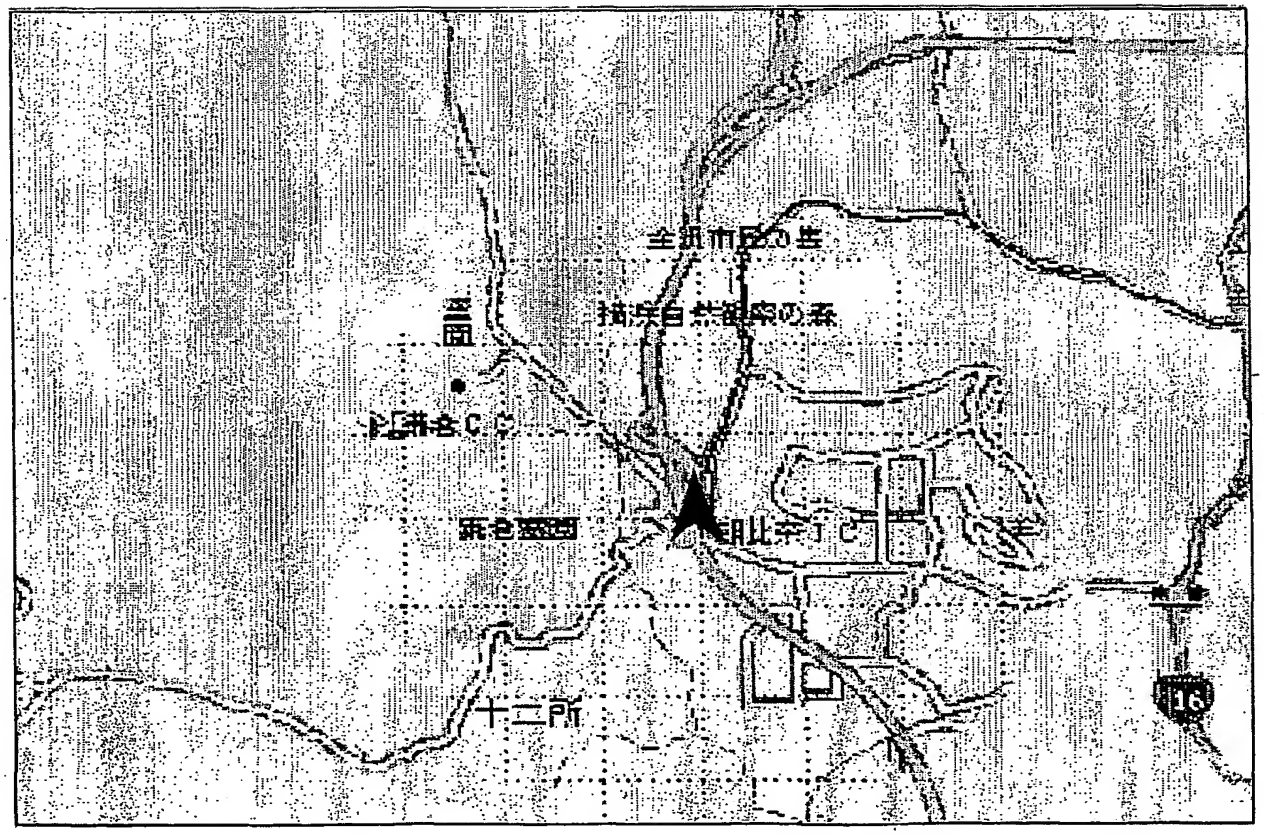


FIG.15

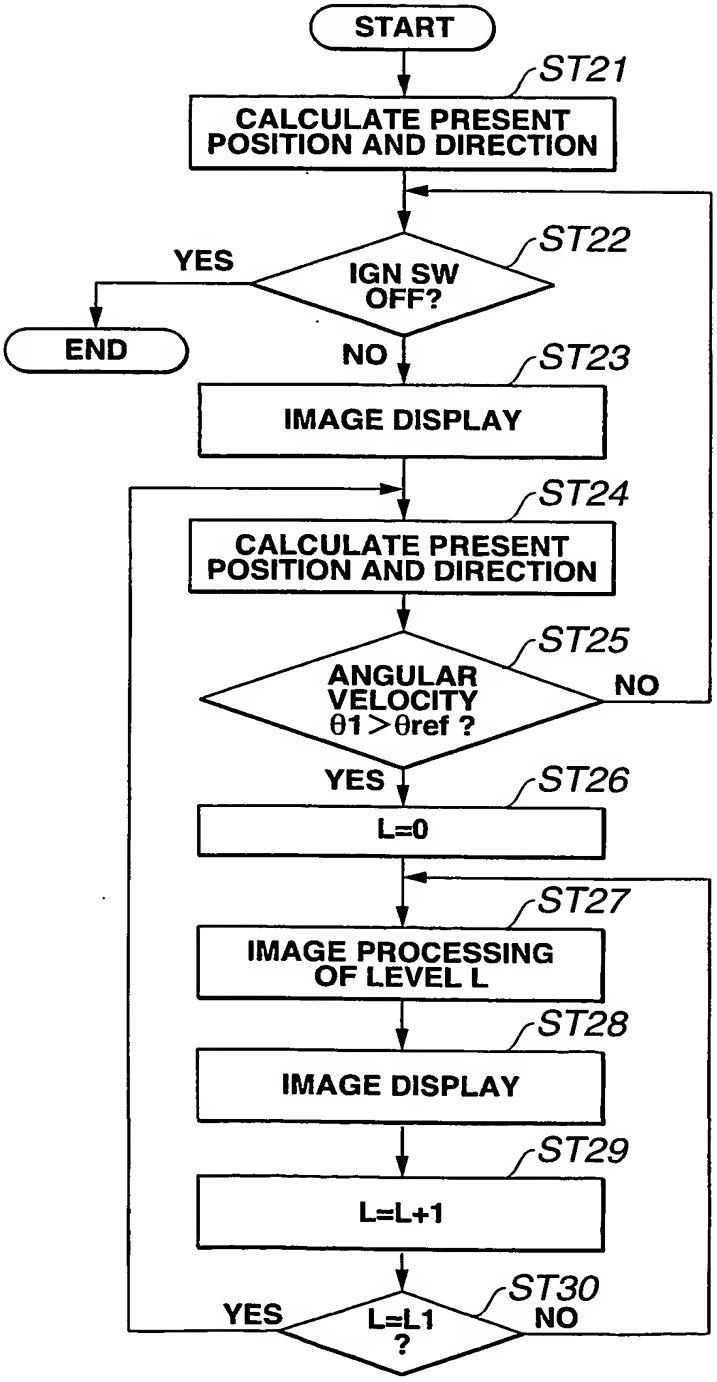

START
ST21
CALCULATE PRESENT POSITION AND DIRECTION
ST22
YES
IGN SW OFF?
END
NO
ST23
IMAGE DISPLAY
ST24
CALCULATE PRESENT POSITION AND DIRECTION
ST25
ANGULAR VELOCITY θ1 > θref ?
NO
YES
ST26
L=0
ST27
IMAGE PROCESSING OF LEVEL L
ST28
IMAGE DISPLAY
ST29
L=L+1
ST30
YES
L=L1 ?
NO

FIG.16

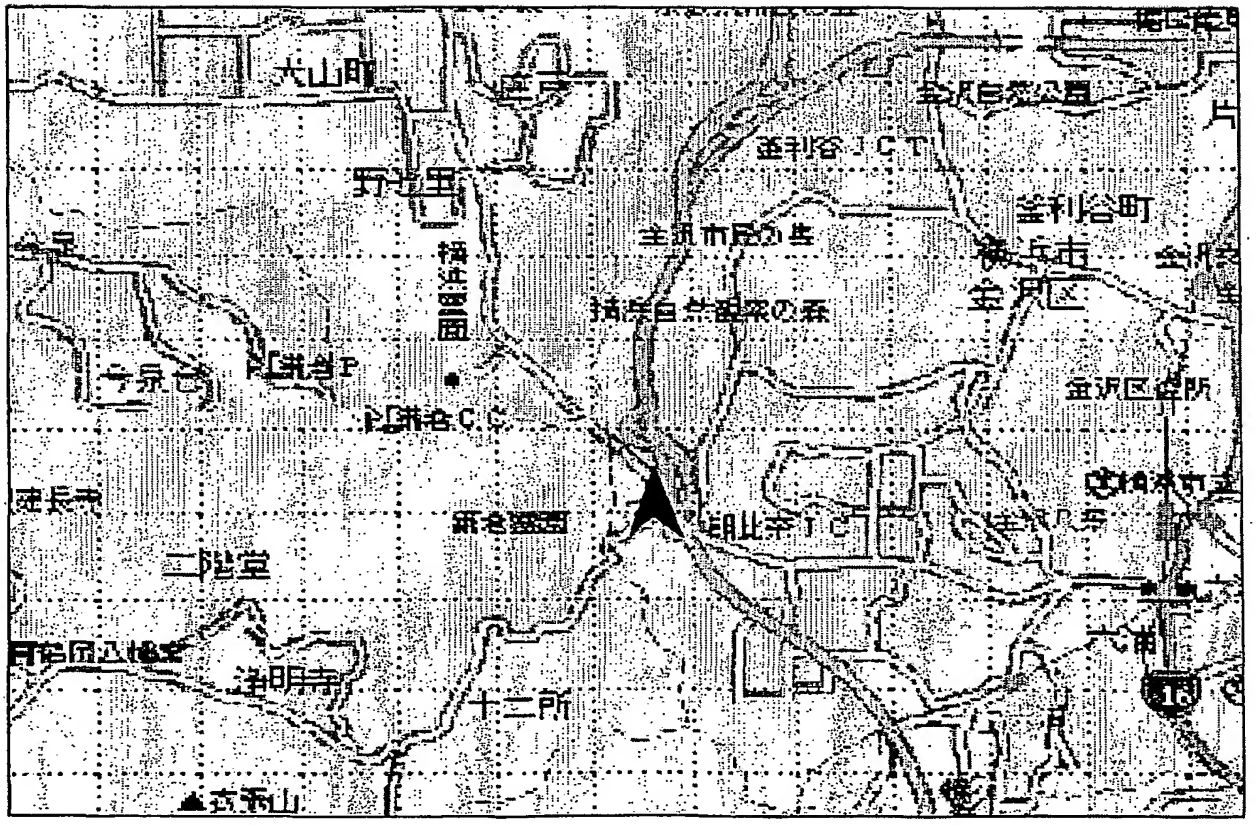


FIG.17

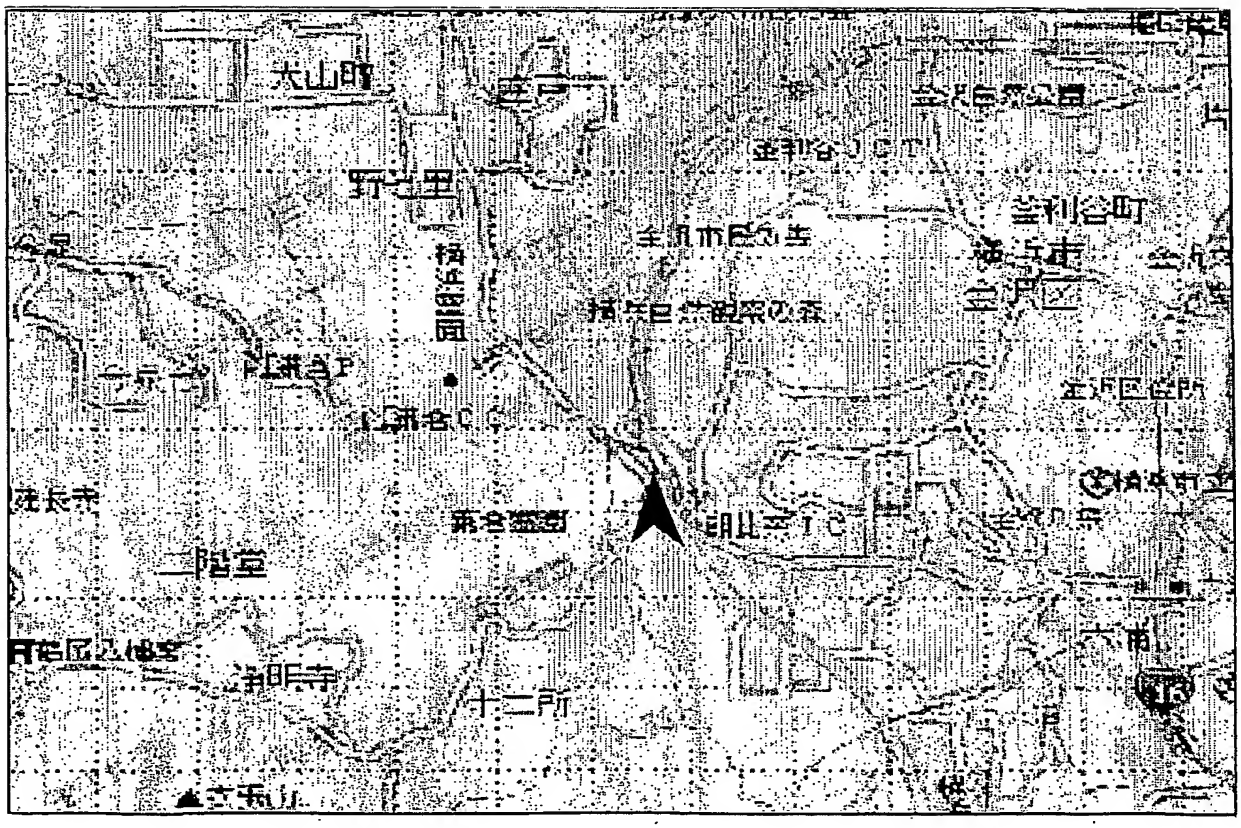


FIG.18

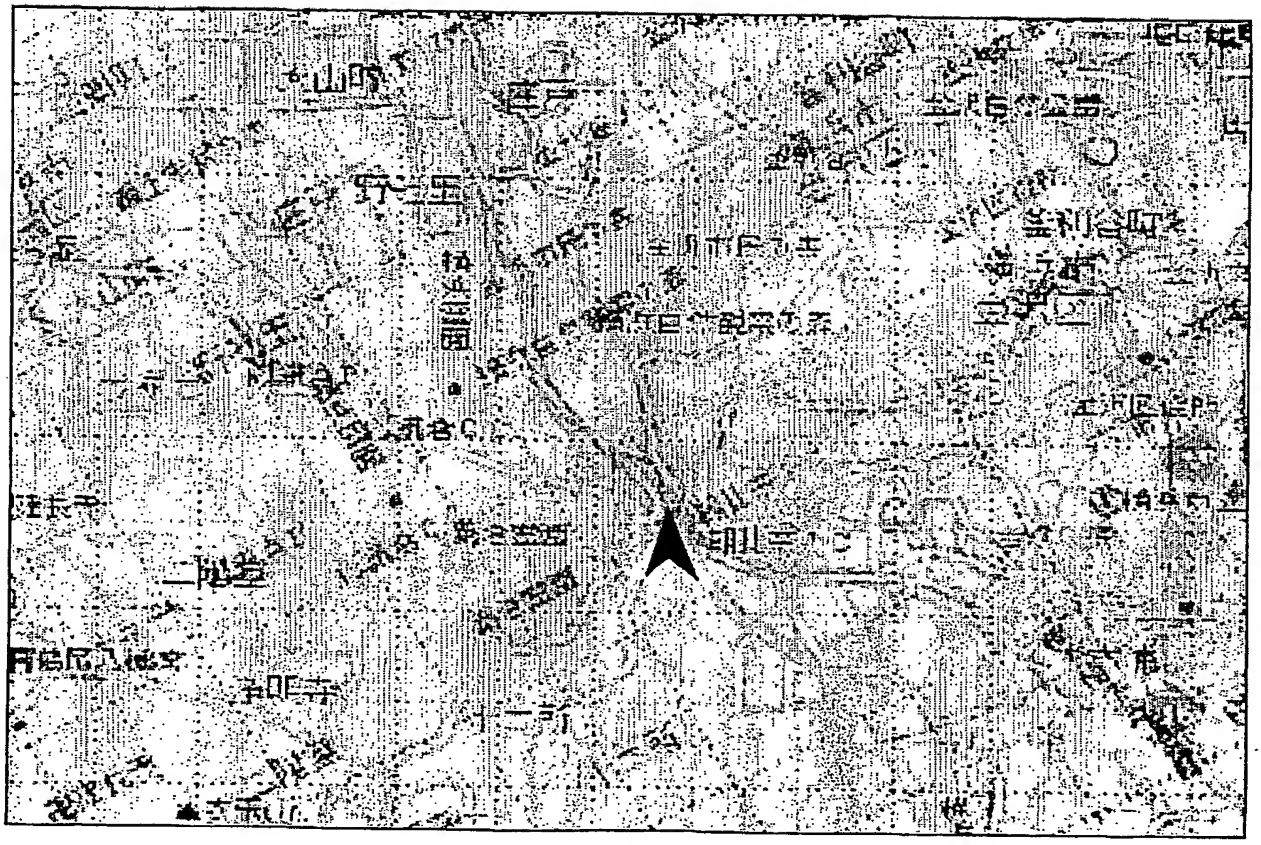


FIG.19

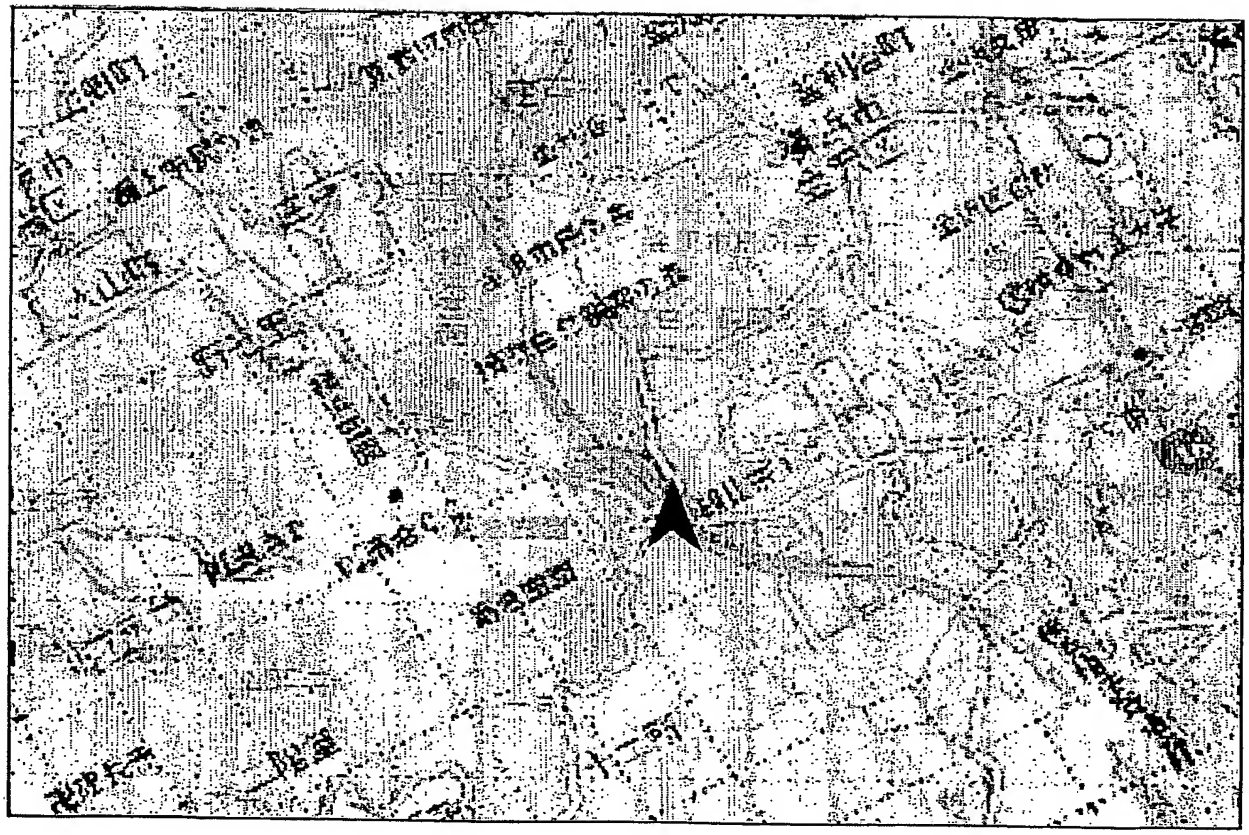


FIG.20

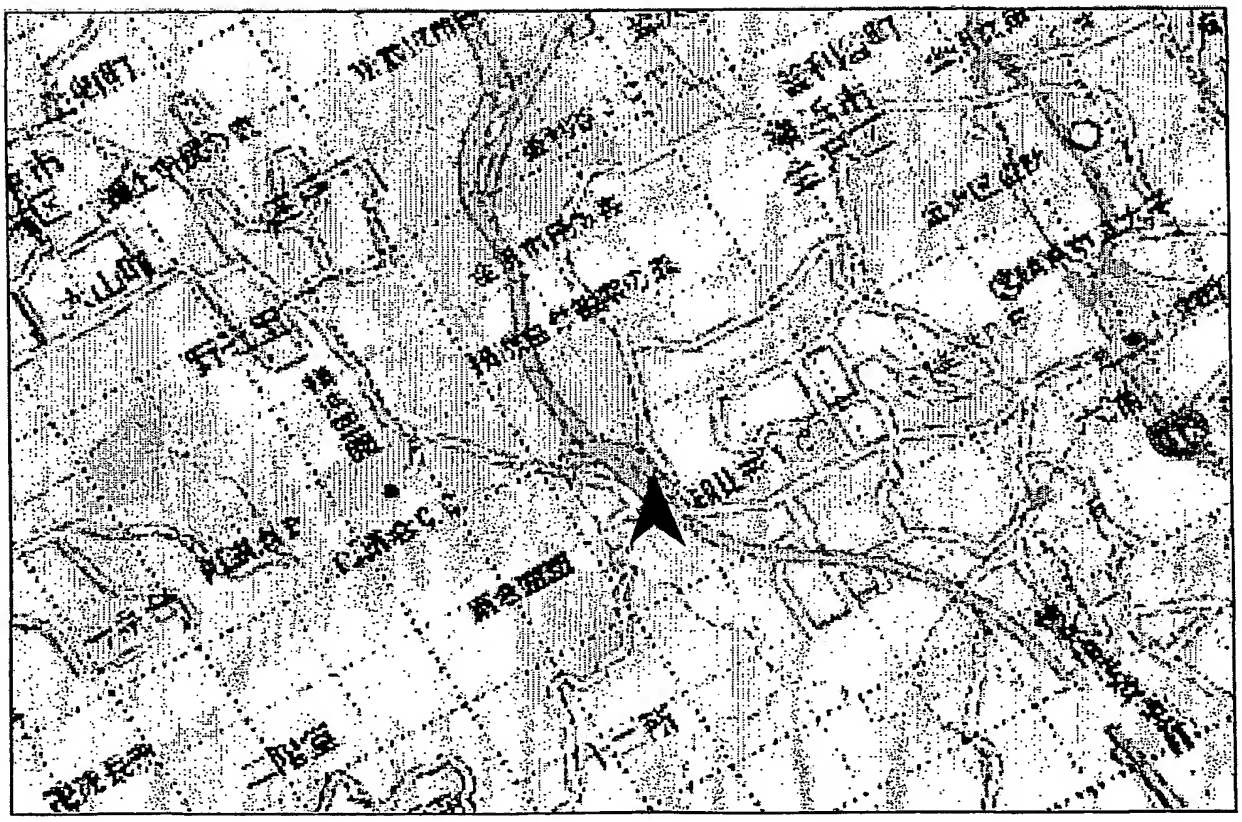


FIG.21

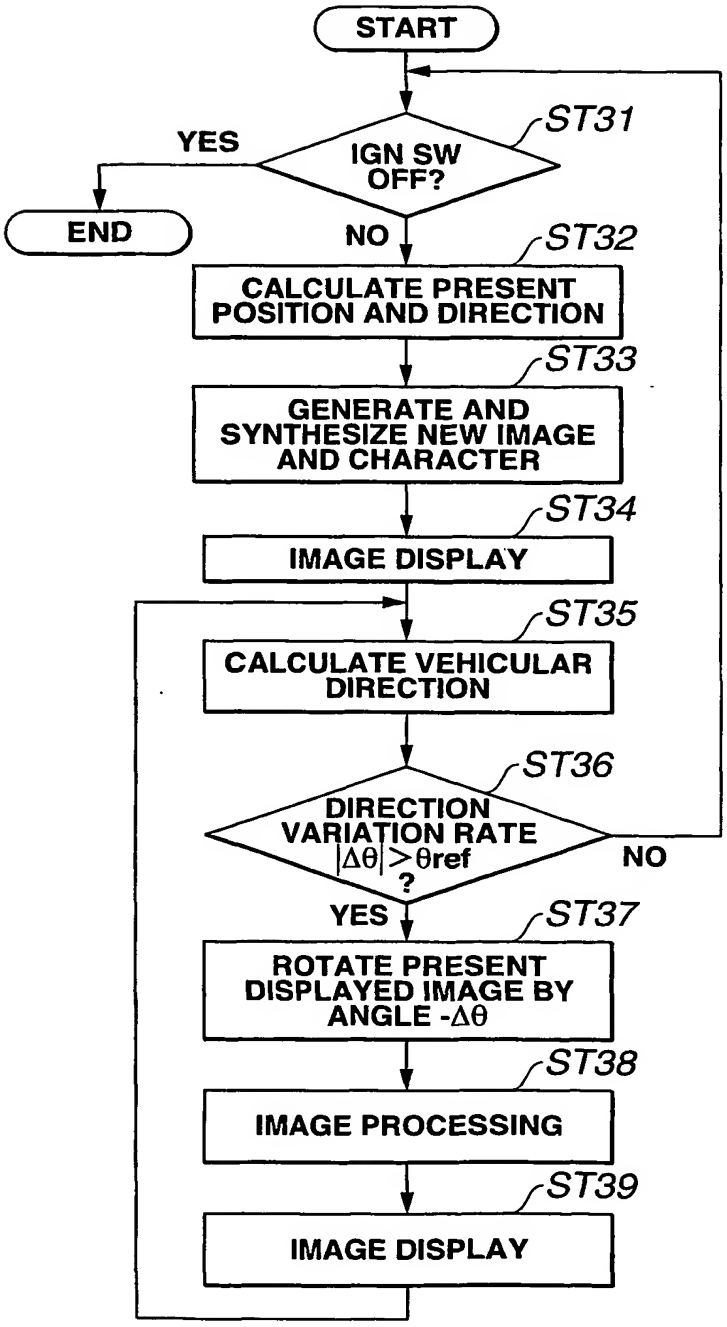

START
ST31
IGN SW OFF?
YES
END
NO
ST32
CALCULATE PRESENT POSITION AND DIRECTION
ST33
GENERATE AND SYNTHESIZE NEW IMAGE AND CHARACTER
ST34
IMAGE DISPLAY
ST35
CALCULATE VEHICULAR DIRECTION
ST36
DIRECTION VARIATION RATE |Δθ| > θref ?
NO
YES
ST37
ROTATE PRESENT DISPLAYED IMAGE BY ANGLE -Δθ
ST38
IMAGE PROCESSING
ST39
IMAGE DISPLAY

FIG.22

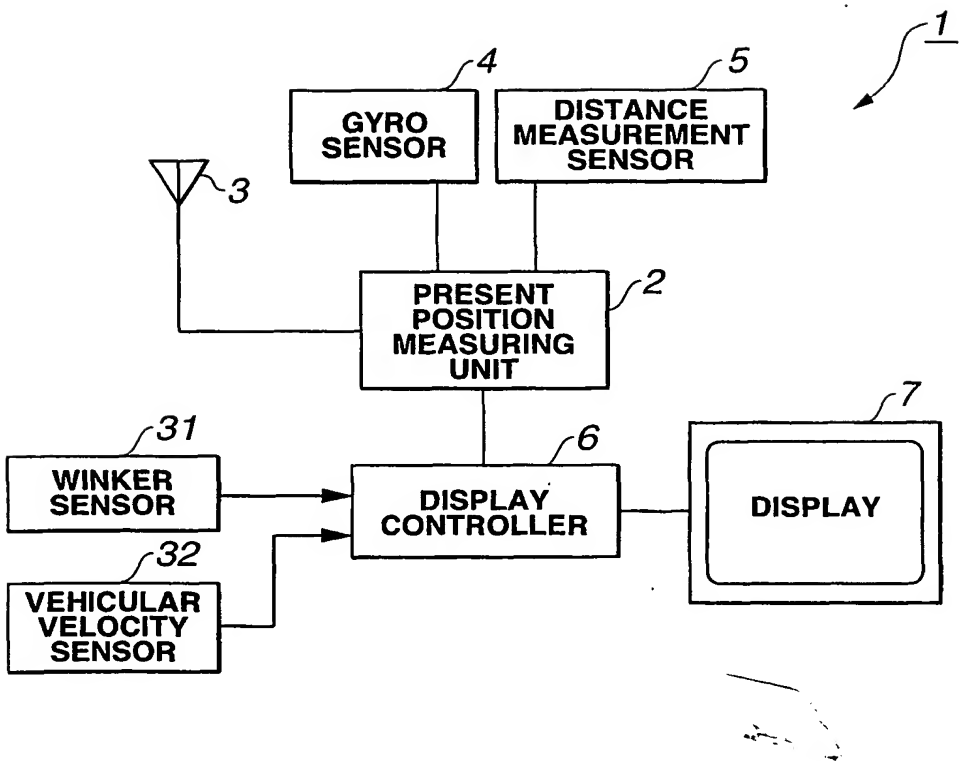

1
4
5
GYRO SENSOR
DISTANCE MEASUREMENT SENSOR
3
PRESENT POSITION MEASURING UNIT
2
7
31
WINKER SENSOR
6
DISPLAY CONTROLLER
DISPLAY
32
VEHICULAR VELOCITY SENSOR

FIG.23

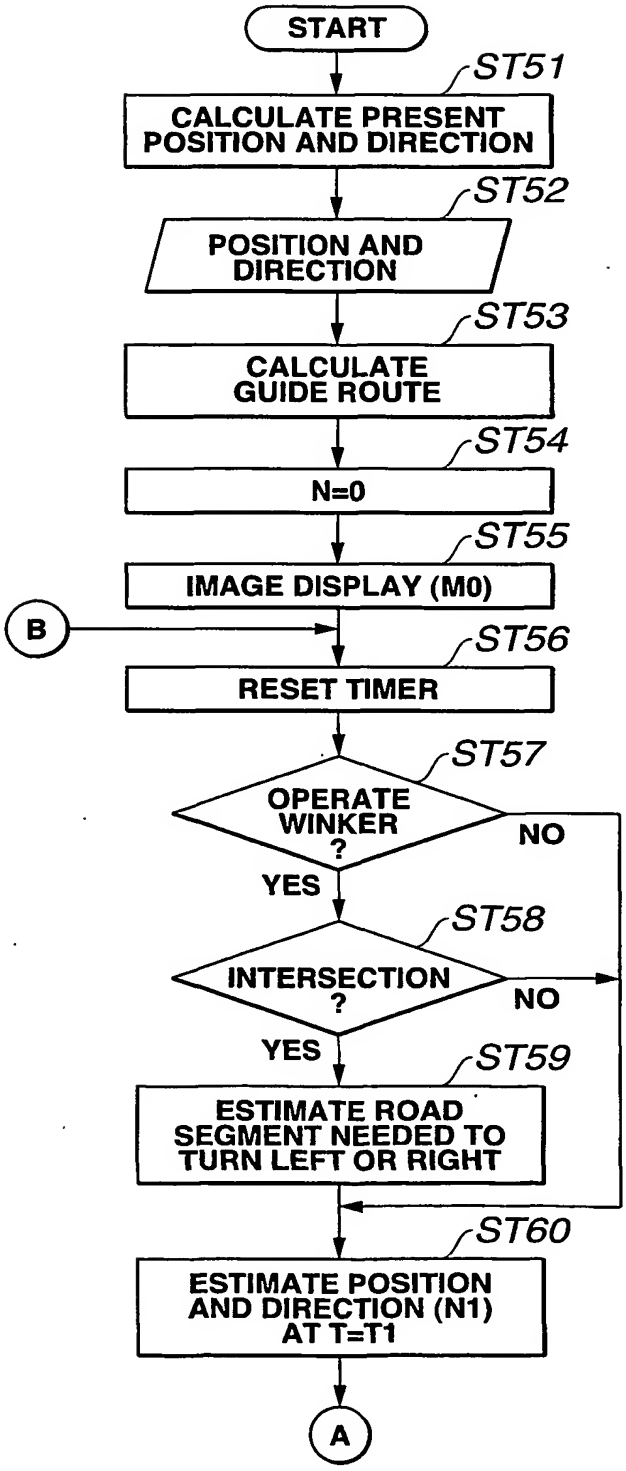

START
ST51
CALCULATE PRESENT POSITION AND DIRECTION
ST52
POSITION AND DIRECTION
ST53
CALCULATE GUIDE ROUTE
ST54
N=0
ST55
IMAGE DISPLAY (M0)
B
ST56
RESET TIMER
ST57
OPERATE WINKER ?
NO
YES
ST58
INTERSECTION ?
NO
YES
ST59
ESTIMATE ROAD SEGMENT NEEDED TO TURN LEFT OR RIGHT
ST60
ESTIMATE POSITION AND DIRECTION (N1) AT T=T1
A

FIG.24

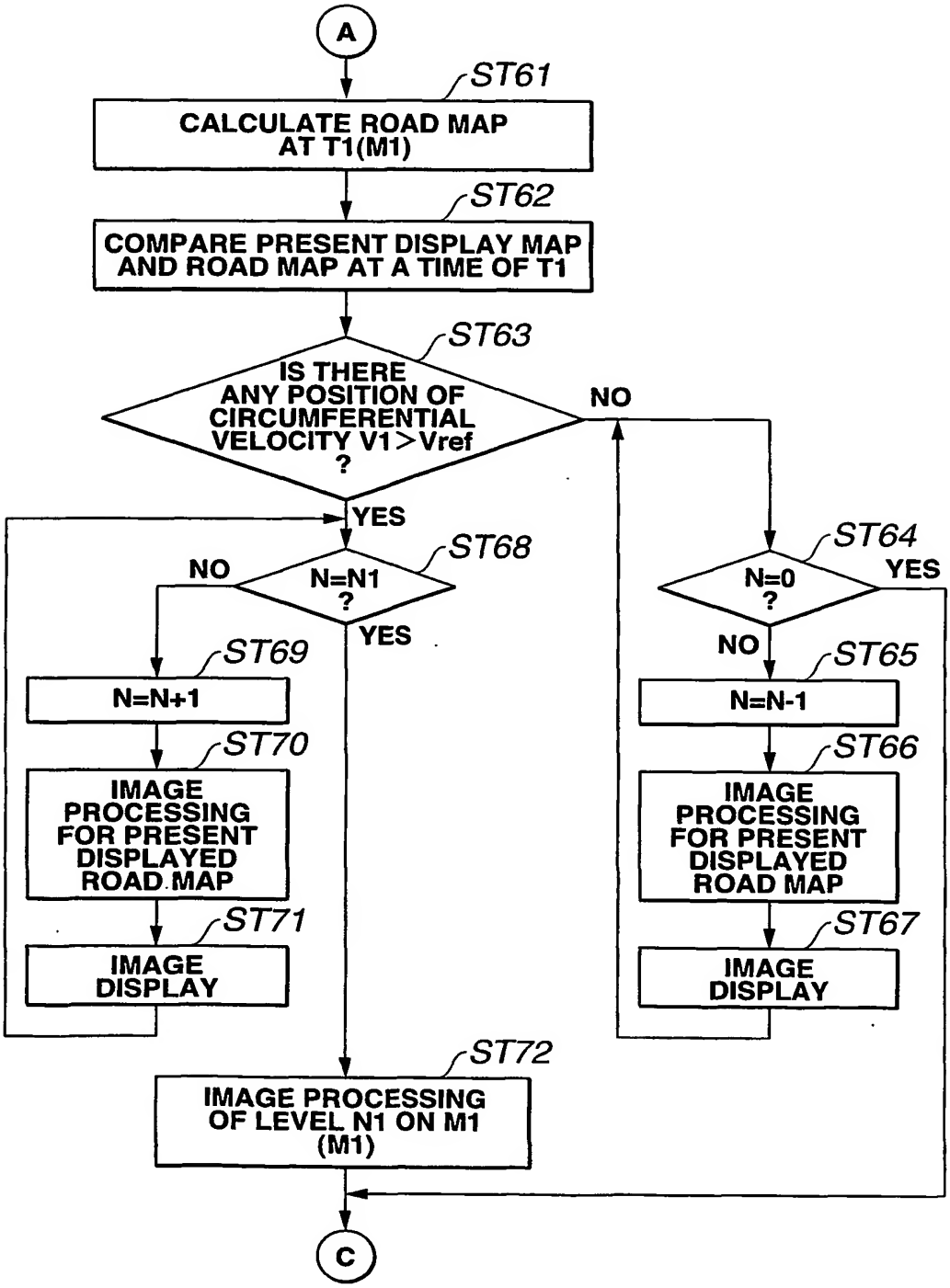

A
ST61
CALCULATE ROAD MAP AT T1(M1)
ST62
COMPARE PRESENT DISPLAY MAP AND ROAD MAP AT A TIME OF T1
ST63
IS THERE ANY POSITION OF CIRCUMFERENTIAL VELOCITY V1>Vref ?
NO
YES
ST68
N=N1 ?
NO
YES
ST69
N=N+1
ST70
IMAGE PROCESSING FOR PRESENT DISPLAYED ROAD MAP
ST71
IMAGE DISPLAY
ST64
N=0 ?
YES
NO
ST65
N=N-1
ST66
IMAGE PROCESSING FOR PRESENT DISPLAYED ROAD MAP
ST67
IMAGE DISPLAY
ST72
IMAGE PROCESSING OF LEVEL N1 ON M1 (M1)
C

FIG.25

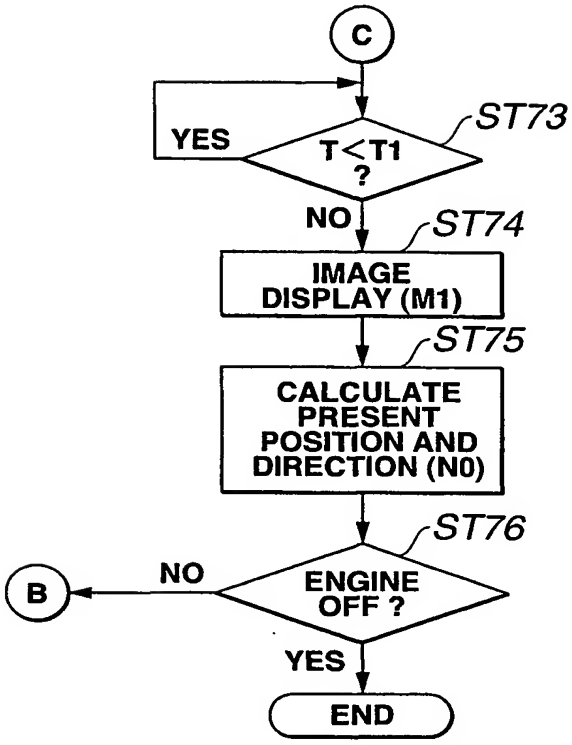
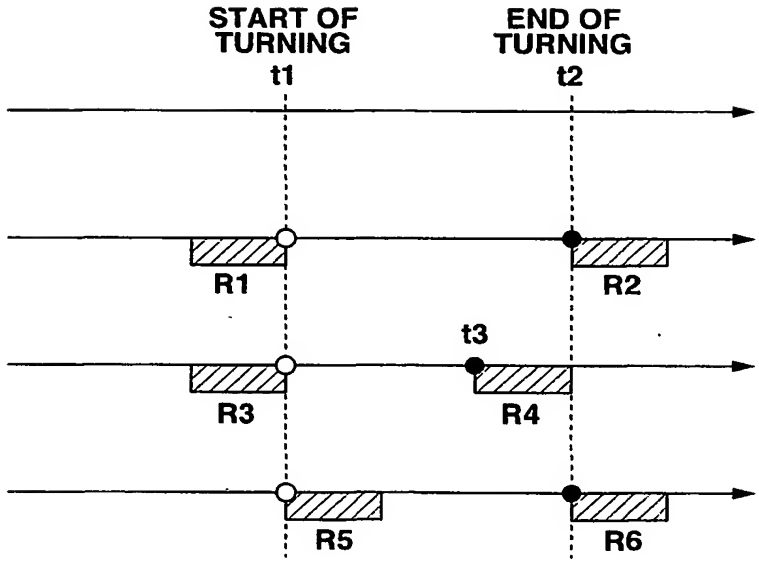

C
ST73
YES
T<T1 ?
NO
ST74
IMAGE DISPLAY (M1)
ST75
CALCULATE PRESENT POSITION AND DIRECTION (N0)
ST76
NO
B
ENGINE OFF ?
YES
END

FIG.26A

FIG.26B

FIG.26C

FIG.26D



○ ··· START OF ROTATION OF ROAD MAP DATA IMAGE

● ··· END OF ROTATION OF ROAD MAP DATA IMAGE

INTERNATIONAL SEARCH REPORT

Int [redacted] Application No
PCT/JP 01/08342

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01C21/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 953 826 A (PIONEER ELECTRONIC CORP) 3 November 1999 (1999-11-03)	1,2,4,5, 7,8,10, 16-18
A	abstract page 11, line 13 - line 28; figures 10B,10C page 11, line 32 - line 38	3
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 11, 30 September 1998 (1998-09-30) & JP 10 148534 A (NISSAN MOTOR CO LTD), 2 June 1998 (1998-06-02) cited in the application abstract	1-3,16, 17

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2002	07/05/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Hunt, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP 01/08342

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 643 (P-1651), 29 November 1993 (1993-11-29) & JP 05 210348 A (MAZDA MOTOR CORP), 20 August 1993 (1993-08-20) abstract	1-3,16, 17

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

In [redacted] Application No
PCT/JP 01/08342

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0953826	A	03-11-1999	JP 11311527 A EP 0953826 A2		09-11-1999 03-11-1999
JP 10148534	A	02-06-1998	NONE		
JP 05210348	A	20-08-1993	NONE		

M-5

10/070951

PATENT COOPERATION TREATY

PCT

10/070951

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
P01NM-072WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/JP 01/08342	26/09/2001	14/11/2000
Applicant		
NISSAN MOTOR CO., LTD.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]JP 01/08342

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01C21/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	abstract page 11, line 13 - line 28; figures 10B,10C page 11, line 32 - line 38	3
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 11, 30 September 1998 (1998-09-30) & JP 10 148534 A (NISSAN MOTOR CO LTD), 2 June 1998 (1998-06-02) cited in the application abstract	1-3,16, 17

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2002	07/05/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hunt, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]/JP 01/08342

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 643 (P-1651), 29 November 1993 (1993-11-29) & JP 05 210348 A (MAZDA MOTOR CORP), 20 August 1993 (1993-08-20) abstract -----	1-3,16, 17

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
JP 01/08342

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0953826 A	03-11-1999	JP 11311527 A	09-11-1999
		EP 0953826 A2	03-11-1999
JP 10148534 A	02-06-1998	NONE	
JP 05210348 A	20-08-1993	NONE	

PATENT COOPERATION TREATY 10/070951

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
SHIGA PATENT OFFICE
Attn. Shiga, Fujiya
Ekisaikai Bldg., 1-29, Akashi-cho
Chuo-ku,Tokyo 104-0044
JAPAN

COMMUNICATION IN CASES FOR WHICH
NO OTHER FORM IS APPLICABLE

Applicant's or agent's file reference P01NM-072WO	Date of mailing *(day/month/year)* 02/11/2001
International application No. PCT/JP 01/08342	**REPLY DUE** See paragraph 1 below
Applicant NISSAN MOTOR CO., LTD.	International filing date *(day/month/year)* 26/09/2001

1. [ ] REPLY DUE within _____ ~~months~~/days from the above date of mailing

   [X] NO REPLY DUE

2. COMMUNICATION:

The applicant is informed that **establishment of the international search report (ISR) may be delayed due to the search backlog in the technical field concerned.** Irrespective of when the applicant receives the ISR however, he must file a demand for international preliminary examination before the expiration of 19 months from the priority date in order to obtain postponement of the time limit for entry into the national phase from 20 (EPO:21) to 30 (EPO:31) months from the priority date (Article 39(1)(a)PCT); **the 19-month time limit is not extendable even if the ISR is delayed.**

In these circumstances, the EPO acting as IPEA will accept, without any late payment fee under Rule 58*bis* PCT, the handling fee and the preliminary examination fee due in respect of the demand relating to the present application, even if they are not paid within the time limit prescribed in Rules 57.3 and 58.1(b)PCT, provided that they are **paid within one month from the date of transmittal of the ISR**; i.e., the EPO will only apply Rule 58*bis* PCT after expiry of this one-month period.
In all cases where the EPO has sent an invitation to pay and the applicant has not paid in full the amount due, the demand shall be considered as if it had not been submitted (Rule 58*bis*.1 (b)-(d) PCT). A loss of rights may well be the consequence in designated states where the time limit for entry into the national phase under Article 22 PCT has already expired (see also Article 37(4) PCT).

Note that if the competent IPEA chosen by the applicant is not the EPO and if the fees mentioned above are not paid within the time limit prescribed in Rules 57.3 and 58.1(b)PCT, the competent IPEA is entitled to apply Rule 58*bis* PCT immediately thereafter.

We apologise for any inconvenience caused.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer ISA/EP

Form PCT/ISA/224 (January 1994)

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF RECEIPT OF RECORD COPY

(PCT Rule 24.2(a))

To:

SHIGA, Fujiya
c/o Shiga Patent Office
Ekisaikai Bldg., 1-29, Akashi-cho
Chuo-ku, Tokyo 104-0044
JAPON

13.11.19

Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
24 October 2001 (24.10.01)	
Applicant's or agent's file reference	**International application No.**
P01NM-072WO	PCT/JP01/08342

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

NISSAN MOTOR CO., LTD. (for all designated States except US)
KATO, Kazuhito et al (for US)

International filing date	:	26 September 2001 (26.09.01)
Priority date(s) claimed	:	14 November 2000 (14.11.00)
Date of receipt of the record copy by the International Bureau	:	12 October 2001 (12.10.01)
List of designated Offices	:	

EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,TR
National :CN,KR,US

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- [X] time limits for entry into the national phase
- [X] confirmation of precautionary designations
- [ ] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:

Y. KUWAHARA

Telephone No. (41-22) 338.83.38

ANNEX TO FORM PCT/IB/301

national application No.
PCT/JP01/08342

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

10/070951

PATENT COOPERATION TREATY

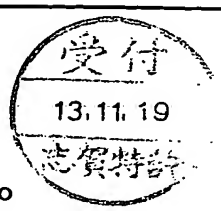
From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:



SHIGA, Fujiya
c/o Shiga Patent Office
Ekisaikai Bldg., 1-29, Akashi-cho
Chuo-ku, Tokyo 104-0044
JAPON

Date of mailing (day/month/year) 24 October 2001 (24.10.01)	
Applicant's or agent's file reference P01NM-072WO	**IMPORTANT NOTIFICATION**
International application No. PCT/JP01/08342	International filing date (day/month/year) 26 September 2001 (26.09.01)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 14 November 2000 (14.11.00)
Applicant NISSAN MOTOR CO., LTD. et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
14 Nove 2000 (14.11.00)	2000-346694	JP	12 Octo 2001 (12.10.01)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Y. KUWAHARA

Telephone No. (41-22) 338.83.38